Series 1953, No. 8 Issued December 1959

SOIL SURVEY

Grand Isle County Vermont

OUR SOIL ★ OUR STRENGTH

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
VERMONT AGRICULTURAL EXPERIMENT STATION

HOW TO USE THE SOIL SURVEY REPORT

THIS SURVEY of Grand Isle County will help people plan the kind of farming that will protect the soils and provide good yields. It describes the soils, shows their location on a map, and tells what they will do under different kinds of management.

The soil survey was made as part of the technical assistance furnished by the Soil Conservation Service to the Grand Isle County Soil Conservation District. Fieldwork for this survey was completed in 1953. Unless otherwise specified, all statements in this report refer to conditions in the county at that time.

Find your farm on the map

In using this survey, start with the soil map bound in the back of this report. These map sheets, if laid together, make a large photographic map of the county as it looks from an airplane. Woods, fields, roads, lakeshore, and many other landmarks can be seen on this map.

To find a farm on the large map, use the index to map sheets. This is a small map marked off in numbered rectangles, each of which corresponds to a sheet of the large map.

Suppose you have found on your farm an area marked with the symbol CbA. You learn the name of the soil this symbol represents by looking at the map legend. The symbol CbA identifies Covington silty clay loam, 0 to 3 percent slopes.

Learn about the soils on your farm

Covington silty clay loam, 0 to 3 percent slopes, and all the other soils mapped in this county are described in the section Descriptions of Soils. Soil scientists walked over the fields and through the woodlands to make maps and gather data for the soil descriptions. They dug pits and studied the soils. They also looked at gravel pits, banks, and roadcuts. They examined surface soils and subsoils; measured slopes with an Abney level; noted differences in growth of crops, weeds, brush, or trees; and recorded all the things that might affect the suitability of the soils for farming and other uses. They mapped the soils on aerial photographs.

After they had mapped and studied the soils, the scientists, with many others, judged what use and management each soil should have. Then they placed it in a management group. A management group consists of soils that need and respond to about the same kind of management. Covington silty clay loam, 0 to 3 percent slopes, is in management group 7. Turn to the section Capability, Management, and Yields and read what is said about the soils in management group 7. Study table 1, which tells how much you can expect to harvest from Covington silty clay loam, 0 to 3 percent slopes. If you are interested in growing trees and want to know what species are suitable for planting on your soils, turn to the section Farm Woodland and Its Management.

Make a farm plan

For the soils on your farm, compare your yields and farm practices with those given in this report. Look at your fields for signs of erosion or need for drainage. Then decide whether or not you need to change your methods. The choice, of course, must be yours. This survey will aid you in planning new methods, but it is not a plan of management for your farm or any other farm in the county.

If you find that you need help in farm planning, consult the local representative of the Soil Conservation Service, who works through the Grand Isle County Soil Conservation District. The county agricultural agent, the members of your State experiment station staff, and others familiar with farming in your county will also be glad to help you.

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SOIL SURVEY OF GRAND ISLE COUNTY, VERMONT

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United States Department of Agriculture in cooperation with the Vermont Agricultural Experiment Station

GRAND ISLE COUNTY lies in the northwestern corner of Vermont (fig. 1). It is composed of four large islands and many small islands in northern Lake Champlain and a peninsula that extends into the lake from the Canadian mainland. The county is the smallest in Vermont. It covers only 1 percent of the area of the State and has 1 percent of the population. Of its 49,280 acres, 92 percent is in farms.

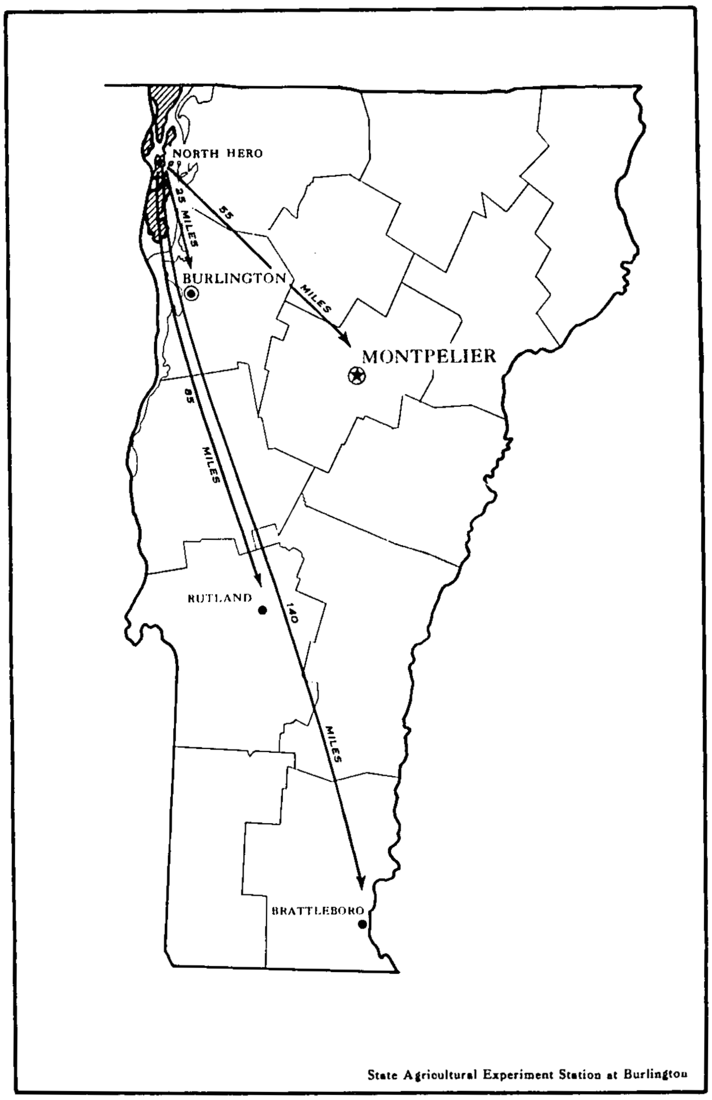

Figure 1.—**Location of Grand Isle County in Vermont.**

Soil Survey Methods and Definitions

The scientist who makes a soil survey examines soils in the field and, according to his observations, maps the boundaries of each soil on an aerial photograph or other map.

FIELD STUDY.—The soil scientist bores or digs many holes to see what the soils are like. The holes are spaced irregularly, depending on the lay of the land. Usually they are not more than a quarter of a mile apart; in many areas they are much closer together. In most soils each boring, hole, or pit reveals several layers, called horizons, which collectively are known as the soil profile. The profile is studied to see how the horizons differ from one another and to learn the things about the soil that influence its capacity to support plants.

Color is usually related to the amount of organic matter. The darker the surface soil, as a rule, the more organic matter it contains. Color is also a clue to the natural drainage conditions. A bright brown subsoil is evidence of good drainage and aeration. Streaks and spots of gray, yellow, and brown show that the soil has a high water table for much of the year and has poor drainage and aeration. A bluish-gray subsoil is characteristic of soils that are waterlogged or covered by water most of the year.

Texture, or the content of sand, silt, and clay, is determined by the way the soil feels when rubbed between the fingers and by laboratory analysis. Texture determines how well the soil retains moisture, plant nutrients, and fertilizer, and whether it is easy or difficult to cultivate.

Structure, which is the way the individual soil particles are arranged in aggregates and the amount of pore space between aggregates, gives clues to the ease or difficulty with which the soil is penetrated by plant roots and by moisture. The aggregates may be prismatic, blocky, platy, or granular. Soil particles are not ordinarily evenly distributed. Channels have been formed by roots and earthworms, and cracks appear when the soils shrink and swell upon drying and wetting. Thus, the soils are a network of channels filled with air, roots, and water, bounded by the irregular surfaces of the soil particles.

Consistence, or the tendency of the soil to crumble or to stick together, indicates whether it is easy or difficult to keep the soil open and porous under cultivation.

Other characteristics observed in the course of the field survey and considered in study of the soil include the following: The depth of the soil over bedrock or compact layers, the presence of gravel or stones in amounts that will interfere with cultivation, the steepness and pattern of slopes, the degree of erosion, the nature of the parent material from which the soil has developed, and the acidity or alkalinity of the soil as measured by chemical tests.

CORRELATION.—On the basis of the characteristics observed by the soil scientists or determined by laboratory tests, soils are correlated by series, types, and phases.

As an example of correlation, consider how the Kendaia series of Grand Isle County is separated into types and phases:

Series	*Types*	*Phases*
Kendaia	Silt loam	0 to 3 percent slopes
		3 to 8 percent slopes
	Very stony silt loam	0 to 3 percent slopes
		3 to 8 percent slopes

Soil series.—Soils similar in kind, thickness, and arrangement of layers are normally designated as a soil series. In a given area, a soil series may be represented by only one soil. When very small areas of two or more kinds of soil are so intricately mixed that they cannot be shown separately on a map of the scale used, they are mapped together and called a soil complex. Only one such complex occurs in Grand Isle County—the St. Albans-Dutchess.

Soil type.—Within a series, there may be one or more soil types. The types are differentiated by the texture of the surface layer.

Soil phase.—Soil types are divided into phases because of differences in slope, number of rock outcrops, degree of erosion, or depth of soil over the substratum.

The phase (or the type, if it has not been subdivided) is the unit shown on the soil map. It is the unit that has the narrowest range of characteristics. Suggestions for use and management, therefore, can be more specific than for soil series or for broader groups that contain more variation.

Miscellaneous land types.—Certain types of land are not classified by soil types and series. They are called land types instead of soils and are identified by descriptive names. The two land types in Grand Isle County are Beach and dune sand and Fresh water marsh.

General Soil Areas

The map of general soil areas at the back of this report shows the pattern of soils in Grand Isle County. Each general area consists of several different soils that occur near one another in a rather characteristic pattern There are five major soil areas.

1. *Level to gently sloping, wet and slightly wet soils: Covington, Kendaia, Swanton, Amenia*

This is the most extensive of the general soil areas. It covers about 44 percent of the county and is distributed in all the towns. Generally it occurs on large flats, but some is on gentle slopes, and some is on stronger slopes. The soils have dark-colored surface layers. They are wet, except for the Amenia soils, which are slightly wet. Generally they are high in lime and are productive when drained. Included are small acreages of many soils that occur in the other general soil areas, but the most extensive soils are those for which the area is named. The Covington and Kendaia soils predominate.

Some areas of Amenia and Kendaia soils are too stony for tillage. The Covington and Swanton soils have few loose surface stones. The tillable areas are used for hay, small grains, pasture, and in many places for silage corn. If the wet soils are drained, they can be worked earlier in spring and can be used for other crops as well.

The Covington, Kendaia, and Swanton soils have formed from different parent materials. The Covington soils are silty clay loams, and the Kendaia and Amenia soils are silt loams. The Swanton soils are fine sandy loams that are underlain by clay at depths of 1 to 4 feet. The Amenia soils have better drainage than the other members of this group.

2. *Productive loamy soils—most are shallow, but some are deep to limestone bedrock: Benson, Amenia, Nellis*

This general soil area is uniformly distributed in all the towns. It covers about 38 percent of the county. The soils occur mainly on gentle, undulating slopes, but the slopes range from nearly level to very steep. These soils are productive. They contain more lime than most of the soils in the county. About one-fifth of the acreage is too stony or too rocky (ledgy) to be tilled. The tillable parts, particularly the Nellis soils, are very productive under good management and are suitable for many crops. They are used for hay, small grains, silage corn, pasture, and in some places for apple orchards. Practically all of the alfalfa produced in the county is grown on Benson, Amenia, and Nellis soils.

The Benson soils occupy about two-thirds of this general soil area. The Amenia and Nellis soils each occupy about one-half of the remainder. The Benson soils are shallow and droughty. The Amenia and Nellis soils are deep and not droughty. The Amenia soils are slightly wet, and the Nellis are well drained.

3. *Bog (organic) soils and very wet soils: Carlisle, Livingston, Balch*

This general soil area covers about 10 percent of the county. It occurs in flat areas or depressions. It is distributed throughout the county. The largest acreage is in the town of Alburg. Many parts of this area are at the level of Lake Champlain and are waterlogged or covered by water most of the year and consequently are too wet for forage crops. However, practically all of the area is included in dairy farms. Most of it is forested, and the rest is either idle or used for native pasture. The trees are largely swamp hardwoods that grow very slowly. Most parts of the area have no drainage outlets.

Carlisle muck is a black soil that has some mineral soil mixed with the well-decomposed organic matter. Balch peat is a brownish, acid soil that contains much undecomposed organic matter. The Livingston soil is a bluish-gray silty clay loam that in places has a black, mucky surface layer 1 to 18 inches thick. Carlisle muck is the most extensive, Livingston is the next largest in acreage, and Balch peat is the smallest. In places there are small areas of Fresh water marsh and other soils.

4. *Nearly level or gently sloping deep sandy and gravelly soils, and sandy soils underlain by clay: Kars, Elmwood, Melrose*

This general soil area covers about 6 percent of the county. It occurs in all of the towns except North Hero. The largest acreage is near Isle La Motte village. Most parts of the area are nearly level to gently sloping. A few are steep. The soils have no surface stones to interfere with tillage. Most of this area has been cleared of trees and is used for the crops needed on dairy farms.

The Kars and Elmwood soils predominate. In some places, Swanton soils are included in the group. The Kars soils are deep and somewhat droughty. They are mildly alkaline at depths of 3 to 5 feet. The Melrose and Elmwood soils are sandy and are underlain by clay at depths of 1 to 4 feet. The Melrose soils are well drained, but the Elmwood soils are slightly wet.

5. *Loamy soils shallow to slate or shale bedrock, and deep wet clayey soils: St. Albans, Dutchess, Covington*

This general soil area covers only about 2 percent of the county. It occurs on the small uninhabited islands in the eastern part and probably will never be used for agriculture. More than half the area is idle. Many places have grown up to sumac and other brushy vegetation; the rest is forested.

The St. Albans, Dutchess, and Covington soils are the most extensive, but other soils are included. The St. Albans and Dutchess soils are acid and droughty. They are shallow to slate or shale bedrock and have outcrops at intervals of 50 to 200 feet. They occur mostly on gently undulating slopes. The Covington soil is a wet silty clay loam. It is level to nearly level. The dominant soils of this general area are of about equal extent.

Capability, Management, and Yields

This section consists of five parts. The first explains the nationwide system of land-capability classification and how the soils of Grand Isle County fit into the capability classes and subclasses. The second deals with soil amendments, erosion control, and other general management practices. The third part discusses 18 management groups of soils. It tells something about the soils in each group and how they should be used and managed. The fourth part is a table showing the estimated yields of the principal crops on each soil in the county. The fifth part is a discussion of farm woodland and its management.

Capability Groups

The soils of Grand Isle County have been grouped in units within capability classes and subclasses. This is part of a nationwide system of capability grouping in which there are eight land capability classes, up to four subclasses in each class, and in each subclass a varying number of units that are groups of similar soils. The units are called management groups in this report.

The eight general classes are based on the degree to which natural features limit the use of each soil or cause risk of damage if it is used for crops, grazing, woodland, or wildlife. A soil is placed in one of the eight classes after study of the uses that can be made of it, the risk of erosion or other damage when it is used, and the need for practices to keep it suitable for use, to control erosion, and to maintain yields.

In classes I, II, and III are soils that are suitable for yearly or periodic cultivation for annual or short-lived crops. Class I soils are those that have the widest range of use and the least risk of damage. They are level or nearly level, productive, generally well drained, and easy to work. They can be cultivated with almost no risk of erosion and will remain productive if managed with normal care. Class II soils can be cultivated regularly, but they do not have quite so wide a range of suitability as class I soils, or they need more protection. Some class II soils are gently sloping and consequently need moderate care to prevent erosion; others are slightly droughty, slightly wet, or somewhat shallow. Class III soils can be cropped regularly but have a narrower range of use and need still more careful management than those in class II.

In class IV are soils that should be cultivated only occasionally or only under very careful management.

In classes V (none in Grand Isle County), VI, and VII are soils that, as a rule, should not be cultivated for annual or short-lived crops but that can be used for pasture, range, woodland, or wildlife habitats. In class VIII are soils that have little value for crops, grazing, or woodland but may be useful as watersheds, as shelters for wildlife, or as sites for recreation.

The soils in each capability class are limited by their natural features to the same degree, but they may be limited for different reasons. To show the main kind of limiting factor, any one of classes II through VIII may be comprised of one to four subclasses, each identified by a letter following the capability class number. The letter "e" indicates that it is chiefly the risk of erosion that limits the use of the soil; the letter "w" signifies that the soil is too wet for general use and needs water control; the letter "s" shows that the soil is shallow, droughty, or unusually low in fertility; and the letter "c" (not used in Grand Isle County) is used to indicate that the climate is so hazardous that it limits the use of the soil.

Within each capability subclass are management groups, each made up of soils that can be managed in the same way. Some of the subclasses consist of only one management group; others consist of two or more groups.

The capability classes, subclasses, and management groups in Grand Isle County are defined in the following list.

Class I.—Soils that have few limitations.
- Management group 1. Deep, nearly level, well-drained soils.

Class II.—Soils slightly limited for use as cropland.
- IIe: Gently sloping soils.
  - Management group 2. Deep loamy soils.
- IIw: Nearly level or gently sloping, slightly wet soils.
  - Management group 3. Deep fine sandy loams, silt loams, or silty clay loams.
- IIs: Nearly level or gently sloping somewhat droughty soils.
  - Management group 4. Mostly shallow rocky loams.

Class III.—Soils severely limited but suitable for regular use as cropland.
- IIIe: Moderately sloping soils that are subject to erosion.
  - Management group 5. Moderately deep to deep silt loams.
  - Management group 6. Deep fine sandy loams.
- IIIw: Level or very gently sloping wet soils.
  - Management group 7. Level or very gently sloping wet soils that can be drained and used for crops.
- IIIs: Moderately sloping droughty soils.
  - Management group 8. Shallow rocky loams.

Class IV.—Soils severely limited for use as cropland; suitable for cultivation part of the time or for special crops.
- IVe: Strongly sloping or rolling soils.
  - Management group 9. Deep fine sandy loams and silt loams.
- IVs: Strongly sloping or rolling soils.
  - Management group 10. Shallow rocky silt loams.

Class VI.—Soils suitable for pasture or trees but not generally suitable for cultivation.
- VIw: Nearly level or depressed soils.
  - Management group 11. Very wet nonstony soils.
- VIs: Nearly level to strongly sloping soils.
  - Management group 12. Deep very stony soils.
  - Management group 13. Very rocky droughty soils.
  - Management group 14. Very stony wet soils.

Class VII.—Soils not suitable for cultivation and severely limited for use as pasture or woodland.
- VIIe: Steep or very steep soils.
  - Management group 15. Sandy loams and shallow silt loams.
- VIIw: Level or depressed soils.
  - Management group 16. Very wet muck, peat, and stony soils.
- VIIs: Steep or very steep soils.
  - Management group 17. Very rocky or very shallow soils.

Class VIII.—Land types not suitable for pasture or trees but that may be suitable recreation sites or may provide shelter for wildlife.
- VIIIw: Flat areas covered by water most of the time.
  - Management group 18. Marsh.
- VIIIs: Mainly gently sloping sandy areas.
  - Management group 18. Beach and dune sand.

General Management and Conservation

Some principles of good management apply to almost all tillable soils. Unless the soils are well managed and conserved, the yields will decrease. For cropland and pasture, (1) use a rotation in which grasses and legumes follow row crops; (2) fertilize according to the current recommendations of the Experiment Station; (3) use enough lime to keep the pH between 6.5 and 7.0; (4) avoid overgrazing and rotate grazing so that there is 6 to 8 inches of growth at the beginning of each grazing period; (5) clip frequently to control weeds and provide even grazing; (6) keep waterways in sod; (7) grow winter cover crops so the land will not be bare.

Rotations.—The common rotation used in Grand Isle County is corn for 1 or 2 years, a small grain, and hay or pasture. Rotations are 4 to 10 years long, depending upon the kind of soil, the fertility level, the size of the farm, and the roughage needs. The quantity or quality (or both) of forage usually decreases after an area has been in sod for 4 years.

A proper rotation (1) systematizes farming; (2) increases crop yields; (3) supplies nitrogen and organic matter; (4) helps control weeds, insects, and plant diseases; and (5) saves labor and distributes it more efficiently.

Ordinarily, the combination of crops in a good rotaonti should include (1) a legume to add nitrogen; (2) a cultivated crop to conserve moisture by controlling weeds; (3) a deep-rooted crop to utilize nutrients in the subsoil and to keep the subsoil permeable; and (4) sod or a close-growing crop to help maintain tilth, to provide regular additions of organic matter, and to help control runoff.

Some crops serve two or more purposes. This reduces the number of crops needed in the rotation. The sequence of crops should be such that the soil is covered as much of the time as possible.

Fertilizers.—In addition to manure and other organic matter, large amounts of nitrogen, phosphate, and potash fertilizer are needed to assure high yields of crops and forage. Frequent light applications of commercial fertilizer are more effective than infrequent heavy applications, especially on sandy soils. Some farmers who cut three crops of alfalfa each year apply a small amount of fertilizer after each cutting.

It is very important to inoculate legume seeds thoroughly before sowing them, so that the bacteria will fix the nitrogen in the soil. The seed should be covered right after seeding; otherwise, the bacteria in the inoculant will die from exposure to sunlight.

Established meadows and pastures should be topdressed with fertilizer at least twice a year—in fall or very early in spring, and right after the first crop. New seedings of oats and barley should be topdressed with fertilizer in fall or early in spring and, if no companion crop is seeded, topdressed again after the weeds are clipped in June.

Farm manure.—Manure is an important fertilizing material. It is impossible, however, to save all of its original fertility. Nitrogen is lost through evaporation and in the liquid that runs off the manure piles. Cows should be provided with adequate bedding, not only to make them more comfortable and to keep them clean but also to absorb the liquid part of the manure, which might otherwise be lost before it is spread.

Manure should be spread on plowed land or plowed under. It can be spread on frozen ground during the winter when the workload on the farm is lightest. Much of the manure produced on dairy farms has to be used for topdressing sod land. Light frequent applications are more effective than infrequent heavy applications.

Lime.—The amount of lime required depends on the type of soil and the crops to be grown. Except for the sandy soils, the soils of this county are naturally high in lime. Those that are high in lime may nonetheless become acid in the plow layer through leaching or the removal of carbonates by crops. A lime test should be made at least once in every rotation. A pH of 6.5 to 7.0 generally should be maintained for best results with grasses and legumes as well as with corn and other field crops.

Management Groups

Within any of the 18 management groups, the soils have generally similar problems and the same general management requirements.

MANAGEMENT GROUP 1: DEEP, NEARLY LEVEL, WELL-DRAINED SOILS

The soils of this management group are in capability class I. They are not subject to erosion. They are—

Kars fine sandy loam, 0 to 3 percent slopes.
Melrose fine sandy loam, 0 to 3 percent slopes.
Nellis silt loam, 0 to 3 percent slopes.

These soils have only minor problems. Ordinary good farming practices will keep them productive. In most years they have neither too much nor too little moisture for crops. Kars fine sandy loam tends to be slightly droughty in dry years.

These soils have developed from different kinds of parent material. The Kars soil has formed from deep sands and gravels that are naturally high in lime at depths of 3 to 5 feet. The Nellis soil has formed from fertile loamy material, and the Melrose from less fertile sands that are underlain by clay at depths of 1 to more than 4 feet.

Most suitable crops.—Corn, small grains, bromegrass, timothy, red clover, and Ladino clover are suitable crops. Corn is especially well suited. In places, the Kars soil may be too droughty for Ladino clover. Alfalfa grows well on the Nellis soil. It can be grown on the Kars and Melrose soils but needs more lime and fertilizer than on the Nellis soil. Tall grasses and legumes that can be used for rotation hay and pasture do well. Winter rye is suitable for a winter cover crop and also provides early grazing in spring.

Cropping system.—A suitable rotation consists of corn, a small grain, and at least 1 year of hay or pasture.

Drainage.—Legumes are apt to be winterkilled if planted in depressions where ice forms. This can be prevented by grading so that water will not stand on the surface.

Tillage problems.—The soils in this group are easy to till and they dry out early in spring.

Fertility.—The Kars and Melrose soils generally need more lime and fertilizer, especially potassium, than the Nellis soil. Since these sandy soils are leached fairly rapidly, frequent light applications of lime and fertilizer are more effective than a single heavy application. Manure will help to increase the fertility and the water-holding capacity of the soils. Nellis silt loam, 0 to 3 percent slopes, has no special fertility problem.

MANAGEMENT GROUP 2: DEEP LOAMY SOILS

These soils are among those in capability subclass IIe. They are subject to erosion. The soils are—

Kars fine sandy loam, 3 to 8 percent slopes.
Melrose fine sandy loam, 3 to 8 percent slopes.
Nellis silt loam, 3 to 8 percent slopes.
St. Albans-Dutchess loams, 3 to 8 percent slopes.

In most years these soils are neither too moist nor too dry for crops. The Kars soil tends to be slightly droughty in dry years.

These soils have developed from different kinds of parent material. The Kars soil has formed from deep sands and gravels that are generally high in lime 3 to 5 feet below the surface. The Melrose has formed from sands that are underlain by clay at depths of 1 to more than 4 feet, and the Nellis from loamy material that is naturally well supplied with lime. The Dutchess soil has developed from acid slaty or shaly material, and the St. Albans from fragments of the underlying slate, shale, and limestone.

Most suitable crops.—Corn, small grains, bromegrass, timothy, red clover, and Ladino clover are suitable crops. Corn grows very well on these soils. The Kars soil is too droughty in some places for Ladino clover. Alfalfa is well suited to the Nellis soil but needs more lime and fertilizer to grow well on the other soils. Tall grasses and legumes that can be used for rotation hay and pasture grow well. Winter rye is a good cover crop.

Cropping system.—A good rotation consists of corn, a small grain, and at least 2 years of hay or pasture.

Conservation.—The soils in this group are subject to erosion if they are cultivated without protection. They should be contour cultivated on short slopes and contour stripcropped on long slopes. Some areas need diversion terraces to intercept and carry off surplus surface water.

Drainage.—Wetness is not a problem on these soils. They do not require drainage.

Tillage problems.—These soils have no tillage problems. They dry out early in spring and are easy to work.

Fertility.—The Kars and Melrose soils commonly need more lime and fertilizer, especially potash, than the other soils in the group. The St. Albans and Dutchess soils ordinarily require more lime and fertilizer than the Nellis soil. Frequent light applications are more effective than a single heavy one.

MANAGEMENT GROUP 3: DEEP FINE SANDY LOAMS, SILT LOAMS, OR SILTY CLAY LOAMS

This management group is in capability subclass IIw. The soils of this group are slightly wet. They are—

Amenia silt loam, 0 to 3 percent slopes.
Amenia silt loam, 3 to 8 percent slopes.
Elmwood fine sandy loam, 0 to 3 percent slopes.
Elmwood fine sandy loam, 3 to 8 percent slopes.
Vergennes silty clay loam, 0 to 3 percent slopes.
Vergennes silty clay loam, 3 to 8 percent slopes.

These soils have developed from different kinds of parent materials. The Amenia soils have formed from loamy material that is naturally well supplied with lime. The Elmwood soils have formed from sands that are underlain by clay at depths of 1 to more than 4 feet, and the Vergennes soils have formed from silts and clays.

Most suitable crops.—Ladino clover, red clover, alsike clover, small grains, birdsfoot trefoil, bromegrass, and timothy grow well on these soils. Ladino clover is especially well suited. Corn is grown on these soils, but it does not grow so well as on soils that have better natural drainage. In places Amenia and Vergennes soils may be a little too wet to produce good stands of alfalfa. Alfalfa can be grown on the Elmwood soils if enough lime and fertilizer are applied.

Cropping system.—Corn, a small grain, and at least 2 years of hay or pasture make a good rotation for most of these soils. On Elmwood fine sandy loam, 0 to 3 percent slopes, corn can be grown for 2 consecutive years. A cover crop should be planted after the corn is harvested the first year.

Conservation.—The soils on slopes of 3 to 8 percent are subject to erosion if they are cultivated without protection; they should be worked across the slope in graded strips. On long slopes, diversion terraces may be needed to dispose of surface water.

Drainage.—Many areas of these soils can be used for hay or pasture without being artificially drained. Corn and alfalfa will do better if the soils are drained. Either open ditches or tiles can be used on the slopes of 0 to 3 percent. On the slopes of 3 to 8 percent, interception drainage ditches and tile can be used. Bothersome wet spots in any of the soils should be tiled. The tile should be set at least 2½ feet deep.

Tillage problems.—The excess moisture in these soils prevents them from being worked early in spring and, at times, in fall. In many years they cannot be worked until late in spring. When not too wet, the Amenia and Elmwood soils are easy to work. The Vergennes soils, however, are generally difficult to work at any time of the year because they are sticky when wet and very hard when dry.

Fertility.—The Amenia and Vergennes soils are naturally high in lime. They are productive and need only average amounts of lime and fertilizer. The Elmwood soils are low in natural fertility and are fairly acid. They commonly need more lime and more fertilizer, especially potash, than either Amenia or Vergennes soils, but they respond well to amendments.

MANAGEMENT GROUP 4: MOSTLY SHALLOW ROCKY LOAMS

This group of soils is in capability subclass IIs. These soils are shallow, and bedrock outcrops in many places. The soils are—

- Benson rocky loam, over massive limestone, 0 to 3 percent slopes.
- Benson rocky loam, over massive limestone, 3 to 8 percent slopes.
- Benson rocky silt loam, over shaly limestone, 0 to 3 percent slopes.
- Benson rocky silt loam, over shaly limestone, 3 to 8 percent slopes.
- St. Albans-Dutchess rocky loams, 3 to 8 percent slopes.

Rocks outcrop every 50 to 200 feet. In the same field there may be both deep and shallow soils; consequently, some parts of a field may be more droughty than others. Bedrock is generally at depths of less than 2 feet. The Benson soils, which are high in lime, are underlain by either hard massive limestone or soft shattered shaly limestone. The St. Albans and Dutchess soils are acid. They overlie acid slate or shale that has occasional seams or layers of limestone.

Most suitable crops.—Alfalfa, red clover, bromegrass, timothy, small grains, and corn are suitable crops. All of these crops do best where the soil is at least 18 inches deep. Ladino clover, because of its shallow root system, does not grow well on these droughty soils. Alfalfa does not grow well on the St. Albans and Dutchess soils unless the soils are adequately limed and fertilized. Tall grasses and legumes that can be used for rotation meadow and pasture are suited to all these soils. Winter rye is a good cover crop.

Cropping system.—A good rotation for this group consists of corn, a small grain, and at least 2 years of hay or pasture.

Conservation.—The soils on slopes of 3 to 8 percent are likely to erode when tilled. They should be worked across the slope in contour strips. Fields that, because of the rock outcrops, are too bumpy to be worked on the contour may be worked in field strips.

Drainage.—Wetness is not a problem.

Tillage problems.—The rock outcrops on these soils interfere with tillage. The plowpoint ordinarily shatters the shaly limestone but not the hard massive limestone.

Fertility.—As a general rule, lime should never be put on the Benson soils unless a soil test indicates it is needed, because spreading lime may do more harm than good. Most of the Benson soils have enough natural lime to make them suitable for alfalfa.

MANAGEMENT GROUP 5: MODERATELY DEEP TO DEEP SILT LOAMS

Because of the risk of erosion, the soils of this group are in capability subclass IIIe. They are—

- Amenia silt loam, 8 to 15 percent slopes.
- Nellis silt loam, 8 to 15 percent slopes.

These soils are productive. They hold a good supply of moisture and are high in lime. The Nellis soil is well drained, and the Amenia is slightly wet.

Most suitable crops.—For Amenia silt loam, 8 to 15 percent slopes, Ladino clover, alsike clover, red clover, birdsfoot trefoil, bromegrass, timothy, small grains, and corn are suitable crops. Ladino clover is especially well suited. Corn and alfalfa are grown, but they are better suited to the better drained Nellis soil.

For Nellis silt loam, 8 to 15 percent slopes, alfalfa and corn are especially suitable. Small grains, Ladino clover, and bromegrass are also suitable.

Cropping system.—A good rotation consists of corn, a small grain, and at least 2 years of hay or pasture.

Conservation.—These soils are erodible and should be worked across the slope—the Amenia soil in graded strips and the Nellis soil in contour strips. Some areas may need diversion terraces to intercept and carry off surface water.

Drainage.—The Nellis soil does not need artificial drainage. Most of the Amenia soil can be used for hay and pasture without artificial drainage, but tile drains will improve its suitability for corn and alfalfa. The tile must be placed deep enough to intercept subsurface water.

Tillage problems.—It is a little difficult to operate modern farm machinery on these sloping soils. The Nellis soil dries out early in spring, but the Amenia soil may be too wet at that time to be worked easily.

Fertility.—There is no special fertility problem.

MANAGEMENT GROUP 6: DEEP FINE SANDY LOAMS

This group of soils is in capability subclass IIIe because of the risk of erosion. The soils in the group are—

- Kars fine sandy loam, 8 to 15 percent slopes.
- Melrose fine sandy loam, 8 to 15 percent slopes.

The Kars soil has formed from deep sands and gravels that are high in natural lime at depths of 3 to 5 feet. The Melrose soil has formed from acid sands that are underlain by clay at depths of 1 to more than 4 feet. Water moves rapidly through the Kars soil, which consequently becomes droughty in dry weather.

Most suitable crops.—Corn, bromegrass, timothy, red clover, and Ladino clover are suitable crops. Alfalfa grows well, provided enough lime and fertilizer have been applied. Ladino clover is likely to die on the drier areas. Corn is especially well suited.

Cropping system.—A good rotation consists of corn, a small grain, and at least 2 years of hay or pasture.

Conservation.—The soils in this group are erodible when tilled. They should be worked across the slope. Contour cultivation is suitable on short slopes, and contour stripcropping is desirable on long slopes. Diversion terraces may be needed on the longer slopes to dispose of surplus surface water. Droughtiness is often a problem. Contour cultivation and stripcropping will conserve water by holding the rainfall so that it will soak in instead of running off.

Tillage problems.—These sandy soils are easy to work, but the slopes make it a little difficult to operate modern farm machinery.

Fertility.—These soils respond well to liming and fertilizing. They particularly need potash. Since fertilizer leaches through these soils rather easily, frequent light applications are more effective than a single heavy one. Manure will improve the fertility and increase the water-holding capacity of these soils.

MANAGEMENT GROUP 7: LEVEL OR VERY GENTLY SLOPING WET SOILS THAT CAN BE DRAINED AND USED FOR CROPS

Because of wetness, the soils in this management group are in capability subclass IIIw. They are—

Covington silty clay loam, 0 to 3 percent slopes.
Covington silty clay loam, 3 to 8 percent slopes.
Kendaia silt loam, 0 to 3 percent slopes.
Kendaia silt loam, 3 to 8 percent slopes.
Swanton fine sandy loam, 0 to 3 percent slopes.
Swanton fine sandy loam, 3 to 8 percent slopes.

These soils remain wet for a long time in spring and become wet early in fall. They are not suited to so wide a range of crops as the better drained soils, but they are high in organic matter and are productive.

The Covington soils have formed from silts and clays. The Kendaia soils have formed from materials that contain less clay and more sand. The Swanton soils have formed from sands underlain by clay at depths of 1 to more than 4 feet.

Most suitable crops.—For areas not drained artificially, birdsfoot trefoil, alsike clover, Ladino clover, and timothy are suitable crops; the wettest areas should be seeded to reed canarygrass when moisture conditions permit.

For areas drained by open ditches, red clover, alsike clover, Ladino clover, birdsfoot trefoil, bromegrass, timothy, corn, small grains, and alfalfa are suitable crops. A stand of alfalfa normally does not last more than 1 or 2 years. Corn is well suited to the Swanton soils, if wet spots are drained by tile. It is suited to the other soils in the group, provided the season is not too wet. For areas drained by a complete system of tile, corn, alfalfa, small grains, Ladino clover, red clover, bromegrass, and timothy are suitable crops. Alfalfa needs more frequent applications of lime and fertilizer on the Swanton soils than on the others.

Cropping system.—A good rotation for this group consists of corn, a small grain, and at least 2 years of hay or pasture. Corn can be grown 2 years in succession on Swanton fine sandy loam, 0 to 3 percent slopes. A cover crop should be planted after the corn is harvested the first year.

Conservation.—The soils on slopes of 3 to 8 percent are erodible. They should be worked across the slope in graded strips. Diversion terraces may be needed to intercept and carry off excess surface water.

Drainage.—A good drainage system makes it possible to utilize the natural fertility of these soils. The choice of crops is wider if the soils are drained, and the soils can be worked earlier in spring. Either ditches or tile drains may be suitable, depending on the slope and the kind of soil. Grading to fill in small depressions will improve surface drainage.

The soils on slopes of 0 to 3 percent can be adequately drained by open ditches. In Covington silty clay loam, 0 to 3 percent slopes, the ditches should be wide and can be shallow enough (about 1 foot deep) to be crossed by farm machinery. In Kendaia silt loam, 0 to 3 percent slopes, the ditches should be about 2½ feet deep, so as to carry off underground water as well as surface water. In Swanton fine sandy loam, 0 to 3 percent slopes, the ditches should be 3 feet deep if the clay layer is 3 or more feet below the surface. If the clay layer is less than 3 feet below the surface, the ditches should be dug at least 6 inches into the clay. The sides and bottoms of the ditches should be seeded promptly after construction to prevent erosion.

The soils on slopes of 3 to 8 percent can be drained by tile. The tile lines should be about 33 feet apart in the Covington soil, about 50 feet apart in the Kendaia soil, and about 100 feet apart in the Swanton soil. The tile should be laid at least 2½ feet deep but generally not more than 3½ feet deep. In the Swanton soil, the joints of the tile lines should be wrapped with tarpaper to keep sand from entering the drains.

Kendaia silt loam, 3 to 8 percent slopes, and Swanton fine sandy loam, 3 to 8 percent slopes, may need interception drainage ditches or tile to intercept seepage water. For effective drainage in the Swanton soil, the tile or the bottom of the ditch should be in the clay layer.

Tillage problems.—The soils in this group are so wet that unless they are artificially drained they cannot be worked until late in spring or, in many years, until early in summer. Harvesting corn in the fall is difficult at times because the soil is so wet. The Covington soils are sticky when wet and very hard when dry.

Fertility.—A soil test should be made before lime is applied, as many areas contain enough natural lime to satisfy the needs of the common crops. Topdressing early in spring with fertilizer high in nitrate nitrogen will help to speed plant growth. The Covington and Kendaia soils require more fertilizer than the sandier Swanton soils to get the same initial response. The Swanton soils may need more potassium than the other soils in this group.

MANAGEMENT GROUP 8: SHALLOW ROCKY LOAMS

The soils in this group are in capability subclass IIIs. They are droughty. The soils are—

Benson rocky loam, over massive limestone, 8 to 15 percent slopes.
Benson rocky silt loam, over shaly limestone, 8 to 15 percent slopes.
St. Albans-Dutchess rocky loams, 8 to 15 percent slopes.

In some areas the slopes are 3 to 8 percent. The rock outcrops are 50 to 200 feet apart. Although depth to bedrock is generally less than 2 feet, it varies from place to place. Consequently, the degree of droughtiness varies in different parts of a field.

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The Benson soils have formed from massive or shaly limestone and are naturally alkaline. The St. Albans and Dutchess soils have formed on slate or shale interbedded with thin layers of limestone. Both of these soils are acid.

Most suitable crops.—Alfalfa, red clover, bromegrass, timothy, small grains, and corn are suitable crops. All these crops grow best where the soil is at least 18 inches deep. Ladino clover is not suited to these droughty soils. Alfalfa could be grown on the St. Albans and Dutchess soils if enough lime and fertilizer were applied. Winter rye and other cover crops are suited to these soils, as well as tall grasses and legumes that can be used for rotation hay and pasture.

Cropping system.—A good rotation consists of corn, a small grain, and at least 3 years of hay or pasture.

Conservation.—The soils in this group are erodible when tilled. They should be worked across the slope in contour strips or, where contour strips are not practicable, in field strips.

Drainage.—Wetness is not a problem.

Tillage problems.—Rock outcrops interfere with tillage. The plowpoint ordinarily shatters the shaly limestone but not the hard massive limestone.

Fertility.—Lime should not be applied to these soils unless a soil test indicates it is needed. Most areas of the Benson soils contain enough lime to be suitable for alfalfa. Spreading lime may do more harm than good.

MANAGEMENT GROUP 9: DEEP FINE SANDY LOAMS AND SILT LOAMS

The soils of this management group are deep, well drained to somewhat droughty, and strongly sloping. Because of risk of erosion, they are in capability subclass IVe. The soils are—

Kars fine sandy loam, 15 to 25 percent slopes.
Melrose fine sandy loam, 15 to 25 percent slopes.
Nellis silt loam, 15 to 25 percent slopes.

The Kars and Melrose soils tend to be somewhat droughty. The Kars has formed from deep sands and gravels that are naturally high in lime at depths of 3 to 5 feet. The Melrose have formed from more acid sands underlain by clay at depths of 1 to 4 feet. The Nellis soil has formed from high-lime loamy material.

Most suitable crops.—Bromegrass, timothy, red clover, and small grains are suitable crops. Alfalfa and Ladino clover are suited to the Nellis soil. The Kars and Melrose soils require more lime and fertilizer than the Nellis to produce good stands of alfalfa. Because of the steep slopes, these soils should be used for tall grasses and legumes instead of row crops.

Cropping system.—A suitable rotation consists of a small grain and at least 3 years of hay or pasture.

Conservation.—These soils should be plowed only when they have to be reseeded. They should be worked across the slope in contour strips. The long slopes need to be protected from runoff, but the slopes are so steep that it is difficult to construct diversion terraces. In places, surface water can be intercepted in the less strongly sloping areas above these soils.

Droughtiness is a problem on some of these soils. More rainwater is absorbed and less is lost through runoff if the long slopes are plowed in contour strips.

Tillage problems.—These soils are easy to work but are so steep that it is difficult to use farm machinery on them.

Fertility.—The Nellis soil is naturally high in lime and is productive if fertilized. The Kars and Melrose soils are less productive but respond well to lime and fertilizer. They usually require potassium. Since the Kars and Melrose soils are rather readily leached, frequent light applications of fertilizer are more effective than a single heavy application. Manure will help to increase the fertility and the water-holding capacity.

MANAGEMENT GROUP 10: SHALLOW ROCKY SILT LOAMS

This management group consists of one shallow, droughty, high-lime soil—Benson rocky silt loam, over shaly limestone, 15 to 25 percent slopes. It is in capability subclass IVs. Rock outcrops about 50 feet apart break the steep slopes.

Most suitable crops.—Alfalfa and bromegrass are the best crops for this soil. Timothy and small grains are also suitable. Because it is steep and rocky, this soil should be used only for long-term hay or for improved pasture.

Cropping system.—A suitable rotation consists of a small grain followed by at least 3 years of hay or pasture.

Conservation.—This soil should be plowed only when the hayfields or pastures need to be reseeded. It should be worked across the slope in contour strips or, where contour strips are not practicable, in field strips.

Tillage problems.—The rock outcrops and the steep slopes make this soil difficult to work.

Fertility.—It is advisable to test this soil before applying lime. Most of it contains enough lime to make it suitable for alfalfa.

MANAGEMENT GROUP 11: VERY WET NONSTONY SOILS

The soils in this group are waterlogged or covered by water a good part of the year. They are in capability subclass VIw. The soils are—

Livingston silty clay loam, 0 to 3 percent slopes.
Lyons silt loam, 0 to 3 percent slopes.
Whately loam, 0 to 3 percent slopes.

The Livingston soil has formed from high-lime clays, the Lyons from loamy material, and the Whately from sands underlain by clay at depths of 1 to 4 feet. Many areas have a black mucky surface layer 1 to 18 inches thick. Many undrained areas are grown up to water-tolerant plants, including swale grasses, sedges, rushes, cattails, alders, and willows.

Most suitable crops.—Undrained areas of these soils will produce nothing but trees or low-quality native pasture. Reed canarygrass will grow if it is seeded during a dry summer when the soils dry out enough to be worked. Ladino clover, alsike clover, birdsfoot trefoil, timothy, and reed canarygrass are suitable crops for areas drained by open ditches. Whately loam, 0 to 3 percent slopes, is the only soil in this group for which tile drainage is feasible. Corn, Ladino clover, red clover, bromegrass, and timothy can be grown on this soil if a complete drainage system is installed.

Drainage.—These soils are difficult to drain because they occur in low areas that lack suitable outlets. Many areas are at lake level. Some areas can be drained by open ditches. In the Livingston soil, the ditches should be at least 1½ feet deep to carry off surface water. Deeper ditches are not normally needed in this soil, because the lateral movement of water is slow. The Lyons soil needs

ditches at least 2½ feet deep to drain off underground water as well as surface water. Open ditches in the Whately soil should be 3 feet deep if the clay layer is 3 or more feet below the surface. If the clay layer is less than 3 feet from the surface, the ditches should be dug at least 6 inches into the clay. The sides and bottoms of the ditches should be seeded immediately to prevent erosion.

If the surface is mucky, the ditches should be dug through the muck into the mineral soil and should be at least as deep as specified for each soil.

Tile drainage is not practicable for Livingston and Lyons soils. In the Whately soil the tile lines should be about 100 feet apart and at least 2½ feet deep. In some places, the tile must be laid deeper so there will be sufficient grade to let the water flow to the outlets. The tile will last longer if laid on top of the clay layer. The joints of the tile lines should be wrapped with tar paper to prevent sand from clogging the drains.

Tillage problems.—In their natural condition, these soils are too wet to be tilled, except in very dry weather.

Fertility.—All crops will grow faster if topdressed early in spring with a fertilizer high in nitrate nitrogen. All the soils are high in organic matter. The Livingston and Lyons soils are naturally high in lime.

MANAGEMENT GROUP 12: DEEP VERY STONY SOILS

The soils in this group are in capability subclass VIs because they are too stony to be tilled. The soils are—

Amenia very stony silt loam, 0 to 3 percent slopes.
Amenia very stony silt loam, 3 to 8 percent slopes.
Amenia very stony silt loam, 8 to 15 percent slopes.
Nellis very stony silt loam, 0 to 3 percent slopes.
Nellis very stony silt loam, 3 to 8 percent slopes.
Nellis very stony silt loam, 8 to 15 percent slopes.
Nellis very stony silt loam, 15 to 25 percent slopes.

The Amenia soils are slightly wet; they contain excess water in spring and, at times, in fall. The Nellis soils are well drained. Both series have developed from high-lime loamy materials. All of these soils hold a good supply of water.

Limitations and suitability.—These soils are suitable for native pasture or trees. They have enough stones on the surface to prevent the use of modern farm machinery. The native pastures produce low-quality roughage consisting of Kentucky bluegrass, povertygrass, wild whiteclover, sedges, and weeds. Sedges are common only on the Amenia soils. The soils in this group are naturally high in lime. They are productive if the surface stones are removed. If more cropland or improved pasture is needed, it may be economical to clear these soils of stones.

As a rule, the most practical use for these soils is woodland. All native species of trees grow well, including many kinds of conifers.

MANAGEMENT GROUP 13: VERY ROCKY DROUGHTY SOILS

The soils of this group are shallow, very droughty, and very rocky. They are in capability subclass VIs. The soils are—

Benson very rocky loam, over massive limestone, 0 to 3 percent slopes.
Benson very rocky loam, over massive limestone, 3 to 8 percent slopes.
Benson very rocky loam, over massive limestone, 8 to 15 percent slopes.
Benson very rocky loam, over massive limestone, 15 to 25 percent slopes.
Benson very rocky silt loam, over shaly limestone, 3 to 8 percent slopes.
Benson very rocky silt loam, over shaly limestone, 8 to 15 percent slopes.
Benson very rocky silt loam, over shaly limestone, 15 to 25 percent slopes.
St. Albans-Dutchess very rocky loams, 3 to 8 percent slopes.
St. Albans-Dutchess very rocky loams, 15 to 25 percent slopes.

These soils are too rocky (ledgy) to be tilled. The outcrops are less than 50 feet apart. In most places the soils are very shallow. The Benson soils have formed from high-lime materials, the Dutchess from fragments of acid rock, and the St. Albans from acid slate or shale interbedded with thin layers of limestone.

Limitations and suitability.—The soils in this group cannot be tilled easily because they are shallow and rocky. They are used for native pasture or trees. The native pastures produce low-quality roughage and dry out early in the season. Seedling trees may die from drought during the first year or two. The trees in the present stands grow slowly.

MANAGEMENT GROUP 14: VERY STONY WET SOILS

This management group consists of level to gently sloping soils that are in capability subclass VIs. They are—

Kendaia very stony silt loam, 0 to 3 percent slopes.
Kendaia very stony silt loam, 3 to 8 percent slopes.

These soils remain wet for a long time in spring and become wet early in fall. They have formed from high-lime materials left by glaciers. They contain a large supply of organic matter.

Limitations and suitability.—In their present condition these soils are suitable for pasture or trees. The native pastures are not very good. They produce low-quality roughage consisting of Kentucky bluegrass, wild whiteclover, weeds, and many water-tolerant plants, such as sedges and rushes. Stoniness and wetness make it difficult to lime, fertilize, and clip the pastures. It would be expensive to clear these soils of stones and drain them so they could be used for crops or improved pasture. If better areas are available for pasture, the best use for these soils is to plant them to trees or to allow them to reforest naturally.

MANAGEMENT GROUP 15: SANDY LOAMS AND SHALLOW SILT LOAMS

This management group consists of steep to very steep droughty soils that are in capability subclass VIIe because of the risk of erosion. The mapping units in this group are—

Benson rocky silt loam, over shaly limestone, 25 to 35 percent slopes.
Benson rocky silt loam, over shaly limestone, 35 to 50 percent slopes.
Kars fine sandy loam, 25 to 50 percent slopes.

The Benson soils are shallow over soft, shattered, shaly limestone. They have formed from rock fragments high in lime. The Kars soil has formed from deep sands and gravels that are generally high in natural lime at depths of 3 to 5 feet.

Limitations and suitability.—These soils are too steep to be cultivated. The most practical use for them is to reforest with red pine or other drought-resistant native trees. Reforested areas should be protected from grazing.

MANAGEMENT GROUP 16: VERY WET MUCK, PEAT, AND STONY SOILS

This management group consists of very wet soils that are in capability subclass VIIw. These soils occur in flat areas or depressions and are waterlogged or covered by water most of the year. Many of the flats are at lake level. Some areas have slopes of 1 to 2 percent; a few have slopes stronger than 4 percent. The mapping units in this group are—

Balch peat.
Carlisle muck.
Lyons very stony silt loam, 0 to 3 percent slopes.

Balch peat and Carlisle muck have formed from organic matter derived mainly from forest vegetation. The Lyons soil has formed from loamy material. The Lyons and Carlisle soils contain a large amount of lime, but the brown Balch peat is strongly acid.

Limitations and suitability.—These soils are so wet that they are useful only for woodland or for habitats for muskrats or waterfowl. The more desirable trees do not grow on these soils. Red maple, elm, and other swamp hardwoods grow on the Lyons and Carlisle soils. Conifers, such as black spruce and tamarack, occur on Balch peat, but they grow very slowly. The areas are too wet to be planted to trees and should be allowed to reseed naturally. Keeping livestock out of open areas will help natural reforestation. Reed canarygrass should do well on Carlisle muck if the soil dries out enough so it can be seeded. The best use for these soils may be to develop them as places for muskrats or waterfowl to feed and live.

MANAGEMENT GROUP 17: VERY ROCKY OR VERY SHALLOW SOILS

The soils of this management group are steep to very steep, very droughty rocky loams. They are in capability subclass VIIs. The mapping units in this group are—

Benson very rocky loam, over massive limestone, 25 to 35 percent slopes.
Benson very rocky silt loam, over shaly limestone, 25 to 50 percent slopes.

These soils have formed from high-lime loamy material. The outcrops of rock are 50 feet or less apart.

Limitations and suitability.—These soils are too rocky, shallow, and steep for crops or pasture. They are suitable only for trees. The trees in the present stands grow slowly, and planted seedlings are likely to die from drought within the first year or two.

MANAGEMENT GROUP 18: BEACH AND DUNE SAND, AND MARSH

This management group consists of land types that occur only along the shores of Lake Champlain. They are in capability class VIII because they are not suitable for cultivation, grazing, or forestry. The mapping units in this group are—

Beach and dune sand.
Fresh water marsh.

Beach and dune sand consists of very droughty sands and, in many places, flat fragments of shale and limestone. It is in capability subclass VIIIs. In a very few places the sands have been blown by winds into small dunes. The slopes range from 0 to 25 percent. About the only use for this land type is recreation. Many of the beaches are excellent for swimming and picnicking.

Fresh water marsh is covered by shallow water most of the year. It is in capability subclass VIIIw. Marsh grasses and rushes are the only plants that grow in these areas. Trees rarely get established. During periods in summer and fall when the water is low, some areas of Fresh water marsh are not covered by water. This land type is useful only as shelter for wildlife, especially waterfowl and muskrats. If areas are developed for wildlife habitats, dikes can be built to keep the water level stable.

Estimated Yields

Table 1 shows estimates of how much the principal crops will yield on each soil in the county, under common management and under improved management. For the soils that can be improved by artificial drainage, estimates of yields are given for both drained and undrained areas. The estimates were made locally by personnel of the Soil Conservation Service and the Extension Service.

Farm Woodland and its Management

When the first white explorers came to the Grand Isles of Lake Champlain in 1609, dense forests were widespread. The trees in low, boggy areas were chiefly spruce, red maple, tamarack, northern whitecedar, and pine. In the better drained areas the trees were red oak, white oak, pine, sugar maple, beech, white ash, basswood, walnut, butternut, hickory, hemlock, and cedar.

The Isles were colonized in 1664. Much of the land was cleared so it could be used for farming. The wood cut was used for fuel and for building materials for houses and forts. Some oak and pine logs were made into rafts and floated to Quebec to be used in building ships. Early accounts state that pines of the virgin forests commonly squared 2 feet in diameter and were 80 feet long.

Today, forests occupy roughly 19 percent (about 9,300 acres) of the land area of the county. Some of the better agricultural soils of the State are in Grand Isle County. They have been cleared and undoubtedly will remain in farm crops. Some of the wet soils and the very shallow soils are still in forest. If farmed and then abandoned, such soils soon revert to forest.

The present trees on the better drained soils are hardwoods. Among them are species of both the Oak-hickory and the Northern hardwood forest types, including red oak, sugar maple, beech, basswood, white ash, bitternut hickory, and shagbark hickory. Intermingled with these trees are white pine, hemlock, northern whitecedar, and eastern redcedar.

The poorly drained soils support some species of both the Oak-hickory and Northern hardwood types, but red maple, American elm, and other swamp hardwoods predominate. The stands also include white pine, northern whitecedar, and hemlock.

In the peat bogs, black spruce and tamarack predominate. Poplar, red maple, and American elm predominate in other very poorly drained areas, but the stands also include some white pine, yellow birch, and northern whitecedar.

Woodland management.—Table 2 shows, for each soil in the county, the site class and the estimated production of timber that can be expected from a 50-year-old stand.

TABLE 1.—*Estimated average acre yields of principal crops under two levels of management*

[In "D" columns are yields from drained soils; in "U" columns are yields from undrained soils. Absence of a figure indicates soil is not suitable for the crop specified or is not generally used for crops]

Soils	Silage corn		Oats for grain		Hay: Bromegrass, alfalfa, and Ladino clover		Hay: Timothy and clover		Pasture [1]
	D	U	D	U	D	U	D	U	
	Tons	*Tons*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*Acres per animal unit* [2]
Amenia silt loam, 0 to 3 percent slopes:									
Common management	8	7	35	23	3.0	2.0	3.0	2.0	1.0
Good management	13	12	50	40	4.5	3.5	3.5	3.0	.7
Amenia silt loam, 3 to 8 percent slopes:									
Common management	9	8	35	23	3.0	2.0	3.0	2.0	1.0
Good management	14	13	50	40	4.5	3.5	3.5	3.0	.7
Amenia silt loam, 8 to 15 percent slopes:									
Common management	9	8	35	23	3.0	2.0	3.0	2.0	1.0
Good management	14	13	50	40	4.5	3.5	3.5	3.0	.7
Amenia very stony silt loam, 0 to 3 percent slopes:									
Common management	------	------	------	------	------	------	------	------	1.5
Good management	------	------	------	------	------	------	------	------	------
Amenia very stony silt loam, 3 to 8 percent slopes:									
Common management	------	------	------	------	------	------	------	------	1.5
Good management	------	------	------	------	------	------	------	------	------
Amenia very stony silt loam, 8 to 15 percent slopes:									
Common management	------	------	------	------	------	------	------	------	1.5
Good management	------	------	------	------	------	------	------	------	------
Balch peat	------	------	------	------	------	------	------	------	------
Beach and dune sand	------	------	------	------	------	------	------	------	------
Benson rocky loam, over massive limestone, 0 to 3 percent slopes:									
Common management	[3]	6	[3]	20	[3]	2.0	[3]	2.0	1.5
Good management	[3]	11	[3]	30	[3]	3.5	[3]	3.0	1.0
Benson rocky loam, over massive limestone, 3 to 8 percent slopes:									
Common management	[3]	6	[3]	20	[3]	2.0	[3]	2.0	1.5
Good management	[3]	11	[3]	30	[3]	3.5	[3]	3.0	1.0
Benson rocky loam, over massive limestone, 8 to 15 percent slopes:									
Common management	[3]	5	[3]	20	[3]	2.0	[3]	1.5	2.0
Good management	[3]	9	[3]	30	[3]	3.0	[3]	2.5	1.0
Benson very rocky loam, over massive limestone, 0 to 3 percent slopes:									
Common management	------	------	------	------	------	------	------	------	4.0
Good management	------	------	------	------	------	------	------	------	------
Benson very rocky loam, over massive limestone, 3 to 8 percent slopes:									
Common management	------	------	------	------	------	------	------	------	4.0
Good management	------	------	------	------	------	------	------	------	------
Benson very rocky loam, over massive limestone, 8 to 15 percent slopes:									
Common management	------	------	------	------	------	------	------	------	4.0
Good management	------	------	------	------	------	------	------	------	------
Benson very rocky loam, over massive limestone, 15 to 25 percent slopes:									
Common management	------	------	------	------	------	------	------	------	------
Good management	------	------	------	------	------	------	------	------	------
Benson very rocky loam, over massive limestone, 25 to 35 percent slopes:									
Common management	------	------	------	------	------	------	------	------	------
Good management	------	------	------	------	------	------	------	------	------
Benson rocky silt loam, over shaly limestone, 0 to 3 percent slopes:									
Common management	[3]	6	[3]	20	[3]	2.5	[3]	2.0	1.5
Good management	[3]	11	[3]	30	[3]	4.0	[3]	3.0	.8
Benson rocky silt loam, over shaly limestone, 3 to 8 percent slopes:									
Common management	[3]	6	[3]	20	[3]	2.5	[3]	2.0	1.5
Good management	[3]	11	[3]	30	[3]	4.0	[3]	3.0	.8
Benson rocky silt loam, over shaly limestone, 8 to 15 percent slopes:									----
Common management	[3]	5	[3]	20	[3]	2.0	[3]	1.5	2.0
Good management	[3]	9	[3]	30	[3]	3.0	[3]	2.5	1.0

See footnotes at end of table.

TABLE 1.—*Estimated average acre yields of principal crops under two levels of management*—Continued

Soils	Silage corn		Oats for grain		Hay: Bromegrass, alfalfa, and Ladino clover		Hay: Timothy and clover		Pasture [1]
	D	U	D	U	D	U	D	U	
Benson rocky silt loam, over shaly limestone, 15 to 25 percent slopes:	*Tons*	*Tons*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*Acres per animal unit* [2]
Common management	[3]	5	[3]	20	[3]	2.0	[3]	1.5	4.0
Good management	[3]	9	[3]	30	[3]	3.0	[3]	2.5	2.0
Benson rocky silt loam, over shaly limestone, 25 to 35 percent slopes:									
Common management	------	------	------	------	------	------	------	------	4.0
Good management	------	------	------	------	------	------	------	------	2.0
Benson rocky silt loam, over shaly limestone, 35 to 50 percent slopes	------	------	------	------	------	------	------	------	------
Benson very rocky silt loam, over shaly limestone, 3 to 8 percent slopes:									
Common management	------	------	------	------	------	------	------	------	4.0
Good management	------	------	------	------	------	------	------	------	------
Benson very rocky silt loam, over shaly limestone, 8 to 15 percent slopes:									
Common management	------	------	------	------	------	------	------	------	4.0
Good management	------	------	------	------	------	------	------	------	------
Benson very rocky silt loam, over shaly limestone, 15 to 25 percent slopes:									
Common management	------	------	------	------	------	------	------	------	4.0
Good management	------	------	------	------	------	------	------	------	------
Benson very rocky silt loam, over shaly limestone, 25 to 50 percent slopes:									
Common management	------	------	------	------	------	------	------	------	4.0
Good management	------	------	------	------	------	------	------	------	------
Carlisle muck	------	------	------	------	------	------	------	------	------
Covington silty clay loam, 0 to 3 percent slopes:									
Common management	10	6	25	10	2.5	.5	2.0	1.5	1.5
Good management	13	8	40	15	4.0	1.5	3.0	2.5	1.0
Covington silty clay loam, 3 to 8 percent slopes:									
Common management	10	6	25	10	2.5	.5	2.0	1.5	1.5
Good management	13	8	40	15	4.0	1.5	3.0	2.5	1.0
Elmwood fine sandy loam, 0 to 3 percent slopes:									
Common management	[3]	8	[3]	20	[3]	1.0	[3]	2.0	1.5
Good management	[3]	13	[3]	40	[3]	3.0	[3]	3.0	1.0
Elmwood fine sandy loam, 3 to 8 percent slopes:									
Common management	[3]	8	[3]	20	[3]	1.0	[3]	2.0	1.5
Good management	[3]	13	[3]	40	[3]	3.0	[3]	3.0	1.0
Fresh water marsh	------	------	------	------	------	------	------	------	------
Kars fine sandy loam, 0 to 3 percent slopes:									
Common management	[3]	8	[3]	20	[3]	1.5	[3]	2.0	2.0
Good management	[3]	14	[3]	40	[3]	4.0	[3]	3.0	.8
Kars fine sandy loam, 3 to 8 percent slopes:									
Common management	[3]	8	[3]	20	[3]	1.5	[3]	2.0	2.0
Good management	[3]	14	[3]	40	[3]	4.0	[3]	3.0	.8
Kars fine sandy loam, 8 to 15 percent slopes:									
Common management	[3]	8	[3]	20	[3]	1.5	[3]	2.0	2.0
Good management	[3]	14	[3]	40	[3]	4.0	[3]	3.0	.8
Kars fine sandy loam, 15 to 25 percent slopes:									
Common management	[3]	8	[3]	20	[3]	1.5	[3]	2.0	2.0
Good management	[3]	14	[3]	40	[3]	4.0	[3]	3.0	.8
Kars fine sandy loam, 25 to 50 percent slopes	------	------	------	------	------	------	------	------	------
Kendaia silt loam, 0 to 3 percent slopes:									
Common management	10	6	25	10	3.0	.5	2.0	1.5	1.5
Good management	13	8	40	15	4.5	1.5	3.0	2.5	1.0
Kendaia silt loam, 3 to 8 percent slopes:									
Common management	10	6	25	10	3.0	.5	2.0	1.5	1.5
Good management	13	8	40	15	4.5	1.5	3.0	2.5	1.0
Kendaia very stony silt loam, 0 to 3 percent slopes:									
Common management	------	------	------	------	------	------	------	------	2.0
Good management	------	------	------	------	------	------	------	------	------

See footnotes at end of table.

TABLE 1.—*Estimated average acre yields of principal crops under two levels of management*—Continued

Soils	Silage corn		Oats for grain		Hay: Bromegrass, alfalfa, and Ladino clover		Hay: Timothy and clover		Pasture [1]
	D	U	D	U	D	U	D	U	
	Tons	*Tons*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*Acres per animal unit* [2]
Kendaia very stony silt loam, 3 to 8 percent slopes:									
Common management	------	------	------	------	------	------	------	------	2.0
Good management	------	------	------	------	------	------	------	------	----------
Livingston silty clay loam, 0 to 3 percent slopes:									
Common management	------	------	------	------	------	------	0.25	------	6.0
Good management	------	------	------	------	------	------	1.0	------	[4] 2.0
Lyons silt loam, 0 to 3 percent slopes:									
Common management	------	------	------	------	------	------	1.0	------	6.0
Good management	------	------	------	------	------	------	2.0	------	[4] 1.5
Lyons very stony silt loam, 0 to 3 percent slopes:									
Common management	------	------	------	------	------	------	------	------	6.0
Good management	------	------	------	------	------	------	------	------	----------
Melrose fine sandy loam, 0 to 3 percent slopes:									
Common management	(3)	7	(3)	20	(3)	1.0	(3)	2.0	1.0
Good management	(3)	13	(3)	40	(3)	3.0	(3)	3.0	.5
Melrose fine sandy loam, 3 to 8 percent slopes:									
Common management	(3)	7	(3)	20	(3)	1.0	(3)	2.0	1.0
Good management	(3)	13	(3)	40	(3)	3.0	(3)	3.0	.5
Melrose fine sandy loam, 8 to 15 percent slopes:									
Common management	(3)	7	(3)	20	(3)	1.0	(3)	2.0	1.0
Good management	(3)	13	(3)	40	(3)	3.0	(3)	3.0	.5
Melrose fine sandy loam, 15 to 25 percent slopes:									
Common management	(3)	7	(3)	20	(3)	1.0	(3)	2.0	2.0
Good management	(3)	13	(3)	40	(3)	3.0	(3)	3.0	1.0
Nellis silt loam, 0 to 3 percent slopes:									
Common management	(3)	10	(3)	30	(3)	3.0	(3)	2.0	1.0
Good management	(3)	15	(3)	50	(3)	4.5	(3)	3.0	.8
Nellis silt loam, 3 to 8 percent slopes:									
Common management	(3)	10	(3)	30	(3)	3.0	(3)	2.0	1.0
Good management	(3)	15	(3)	50	(3)	4.5	(3)	3.0	.8
Nellis silt loam, 8 to 15 percent slopes:									
Common management	(3)	10	(3)	30	(3)	3.0	(3)	2.0	1.0
Good management	(3)	15	(3)	50	(3)	4.5	(3)	3.0	.8
Nellis silt loam, 15 to 25 percent slopes:									
Common management	(3)	10	(3)	30	(3)	3.0	(3)	2.0	1.0
Good management	(3)	15	(3)	50	(3)	4.5	(3)	3.0	.8
Nellis very stony silt loam, 0 to 3 percent slopes:									
Common management	------	------	------	------	------	------	------	------	2.0
Good management	------	------	------	------	------	------	------	------	----------
Nellis very stony silt loam, 3 to 8 percent slopes:									
Common management	------	------	------	------	------	------	------	------	2.0
Good management	------	------	------	------	------	------	------	------	----------
Nellis very stony silt loam, 8 to 15 percent slopes:									
Common management	------	------	------	------	------	------	------	------	2.0
Good management	------	------	------	------	------	------	------	------	----------
Nellis very stony silt loam, 15 to 25 percent slopes:									
Common management	------	------	------	------	------	------	------	------	2.0
Good management	------	------	------	------	------	------	------	------	----------
St. Albans-Dutchess loams, 3 to 8 percent slopes	------	------	------	------	------	------	------	------	----------
St. Albans-Dutchess rocky loams, 3 to 8 percent slopes	------	------	------	------	------	------	------	------	----------
St. Albans-Dutchess rocky loams, 8 to 15 percent slopes	------	------	------	------	------	------	------	------	----------
St. Albans-Dutchess very rocky loams, 3 to 8 percent slopes	------	------	------	------	------	------	------	------	----------
St. Albans-Dutchess very rocky loams, 15 to 25 percent slopes	------	------	------	------	------	------	------	------	----------
Swanton fine sandy loam, 0 to 3 percent slopes:									
Common management	8	6	25	10	1.0	.5	2.0	1.5	2.0
Good management	14	8	40	15	3.0	1.0	3.0	2.5	1.0
Swanton fine sandy loam, 3 to 8 percent slopes:									
Common management	8	6	25	10	1.0	.5	2.0	1.5	2.0
Good management	14	8	40	15	3.0	1.0	3.0	2.5	1.0
Vergennes silty clay loam, 0 to 3 percent slopes:									
Common management	(3)	8	(3)	20	(3)	2.5	(3)	2.0	1.5
Good management	(3)	12	(3)	35	(3)	4.0	(3)	3.0	.7

See footnotes at end of table.

TABLE 1.—*Estmated average acre yields of principal crops under two levels of management*—Continued

Soils	Silage corn		Oats for grain		Hay				Pasture [1]
					Bromegrass, alfalfa, and Ladino clover		Timothy and clover		
	D	U	D	U	D	U	D	U	
Vergennes silty clay loam, 3 to 8 percent slopes:	*Tons*	*Tons*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*Acres per animal unit* [2]
Common management	(3)	8	(3)	20	(3)	2. 5	(3)	2. 0	1. 5
Good management	(3)	12	(3)	35	(3)	4. 0	(3)	3. 0	. 7
Whately loam, 0 to 3 percent slopes:									
Common management	------	------	------	------	------	------	------	. 5	4. 0
Good management	------	------	------	------	------	------	------	1. 0	[4] 1. 5

[1] Estimate given under common management is for native pasture, that is, pasture that has been cleared of trees and on which grow Kentucky bluegrass, povertygrass, sedges, rushes, whiteclover, and weeds. Estimate under good management is for improved pasture, that is, land that has been cleared of trees and stones, limed, and seeded to a mixture of legumes and tall grasses. Some have been fertilized and rotated.

[2] Acres per animal unit means the average number of acres required to furnish adequate grazing for 1 animal unit for 180 days without injury to the pasture. An animal unit is 1 cow, steer, or horse, or 7 sheep.

[3] Soil does not need artificial drainage.

[4] Only if seeded to reed canarygrass.

The production figures are based on studies made by the Vermont Department of Forests and Parks and by the Soil Conservation Service. The site class denotes the capability of the soil to produce timber. Site 1 is the most productive, and site 4 is the least. Some areas of the very rocky Benson soils and of the St. Albans and Dutchess soils produce less than the table indicates because of the prevalence of rock outcrops.

Table 2 also shows what species of trees are suitable for planting on each of the soils in the county. Some abandoned land is reforested naturally with useful kinds of trees, but it may be many years before a forest is established by natural reseeding.

Forest stands should be thinned and cleared of weed trees and brush, so the useful trees will have room to grow. The trees should be cut according to plan—for example, for selective harvesting or for salvage and improvement. Frequent cuttings are more economical and more effective in promoting growth than infrequent cuttings. The woodland should not be grazed, and it should be protected from fire.

Woodlands provide income from the sale of logs, bolts, and cordwood. Sometimes there is a market for cones, either for seed or for decorations. Christmas trees can be grown for sale. Some sugarbushes are used commercially, and other stands of sugar maples could be developed for seed use.

Descriptions of Soils

This section describes the soil series (groups of soils with the same proper name) and single soils (mapping units) of Grand Isle County. Here is the method followed:

First, the soil series is described in detail. An important part of this description is the soil profile, a record of what the soil surveyor saw and learned when he dug into the ground. The profile described for each series was taken at a location within one of the mapping units belonging to that series. It is called a "typical" profile because, except for minor variations, it is the kind of profile that will be found in all of the soils of the given series.

Each of the mapping units, or soils, in a series is described next. The description of each soil is brief, because all the soils in one series are basically the same. The emphasis is on those characteristics that other soils of the same series do not have or have in a different degree.

The location and distribution of the single soils, or mapping units, are shown on the soil map at the back of this report. Their land use, approximate acreage, and proportionate extent are shown in table 3.

Definitions of "series," "phases," and other special terms used in describing soils are in the section Soil Survey Methods and Definitions.

Amenia Series

The Amenia series consists of slightly wet loamy soils that have formed from high-lime material left by glaciers. These soils have a brown subsoil that is mottled with olive brown in the lower part and an underlying dark-gray layer also mottled with olive brown. In many places the dark-gray layer is so hard it is difficult to dig with a spade. Most of the soils in this series are gently sloping, but they range from level to very steep.

Amenia soils occur throughout the county, generally in small areas. They are most common in the northwestern part of the town of Alburg. Most areas are adjacent to or near the droughty, shallow Benson soils, the well-drained Nellis soils, the wet Kendaia soils, and the very wet Lyons soils.

Among the native plants are povertygrass, Kentucky bluegrass, wild whiteclover, and sedges.

The trees in the forested areas are mixed hardwoods, mainly sugar maple, beech, yellow birch, and white ash. Hickory, basswood, red oak, white oak, red maple, whitecedar, and hemlock trees also grow in the stands.

TABLE 2.—*Estimated volume of timber per acre to be expected from fully stocked 50-year-old stands; site classes, existing forest types, and suitable species of trees for planting on each soil*

[Absence of figures indicates land type is not suited to trees]

Soils	Existing forests: Site class	Existing forests: Forest type [1]	Volume per acre [2]: Cubic feet	Volume per acre [2]: Cords	Suitable species for planting
Amenia silt loam, 0 to 3 percent slopes	1	NH	3,000–3,400	30–32	Norway spruce, white spruce, red spruce, red pine, white pine, sugar maple, whitecedar, and European larch.
Amenia silt loam, 3 to 8 percent slopes	1	NH	3,000–3,400	30–32	Same.
Amenia silt loam, 8 to 15 percent slopes	1	NH	3,000–3,400	30–32	Same.
Amenia very stony silt loam, 0 to 3 percent slopes	1	NH	3,000–3,400	30–32	Same.
Amenia very stony silt loam, 3 to 8 percent slopes	1	NH	3,000–3,400	30–32	Same.
Amenia very stony silt loam, 8 to 15 percent slopes	1	NH	3,000–3,400	30–32	Same.
Balch peat	4	[3] SH	1,000 or less	12 or less	None.
Beach and dune sand					
Benson rocky loam, over massive limestone, 0 to 3 percent slopes.	3	NH	2,000–2,300	18–20	Norway spruce, red pine, white pine, and whitecedar.
Benson rocky loam, over massive limestone, 3 to 8 percent slopes.	3	NH	2,000–2,300	18–20	Same.
Benson rocky loam, over massive limestone, 8 to 15 percent slopes.	3	NH	2,000–2,300	18–20	Same.
Benson very rocky loam, over massive limestone, 0 to 3 percent slopes.	4	NH	1,000–1,800	12–16	Usually survival is too poor to warrant planting. Red pine might grow.
Benson very rocky loam, over massive limestone, 3 to 8 percent slopes.	4	NH	1,000–1,800	12–16	Same.
Benson very rocky loam, over massive limestone, 8 to 15 percent slopes.	4	NH	1,000–1,800	12–16	Same.
Benson very rocky loam, over massive limestone, 15 to 25 percent slopes.	4	NH	1,000–1,800	12–16	Same.
Benson very rocky loam, over massive limestone, 25 to 35 percent slopes.	4	NH	1,000–1,800	12–16	Same.
Benson rocky silt loam, over shaly limestone, 0 to 3 percent slopes.	1	NH	2,700–3,100	28–32	Red pine and white pine, whitecedar, Norway spruce, sugar maple.[4]
Benson rocky silt loam, over shaly limestone, 3 to 8 percent slopes.	1	NH	2,700–3,100	28–32	Same.
Benson rocky silt loam, over shaly limestone, 8 to 15 percent slopes.	1	NH	2,700–3,100	28–32	Same.
Benson rocky silt loam, over shaly limestone, 15 to 25 percent slopes.	1	NH	2,700–3,100	28–32	Same.
Benson rocky silt loam, over shaly limestone, 25 to 35 percent slopes.	[5] 2	NH	2,500–2,700	25–28	Usually survival is too poor to warrant planting. Red pine might grow.
Benson rocky silt loam, over shaly limestone, 35 to 50 percent slopes.	2	NH	2,500–2,700	25–28	Same.
Benson very rocky silt loam, over shaly limestone, 3 to 8 percent slopes.	3	NH	2,000–2,400	18–20	Same.
Benson very rocky silt loam, over shaly limestone, 8 to 15 percent slopes.	3	NH	2,000–2,400	18–20	Same.
Benson very rocky silt loam, over shaly limestone, 15 to 25 percent slopes.	3	NH	2,000–2,400	18–20	Same.
Benson very rocky silt loam, over shaly limestone, 25 to 50 percent slopes.	3	NH	2,000–2,400	18–20	Same.
Carlisle muck	4	SH	2,000 or less	17 or less	None.
Covington silty clay loam, 0 to 3 percent slopes	3	SH–NH	2,100–2,400	23–25	Whitecedar, white spruce,[6] possibly European larch.
Covington silty clay loam, 3 to 8 percent slopes	3	SH–NH	2,100–2,400	23–25	Same.
Elmwood fine sandy loam, 0 to 3 percent slopes	1	NH	2,700–3,100	28–32	Norway, white, and red spruces, red and white pines, sugar maple, European larch.
Elmwood fine sandy loam, 3 to 8 percent slopes	1	NH	2,700–3,100	28–32	Same.
Fresh water marsh					
Kars fine sandy loam, 0 to 3 percent slopes	2	NH	2,400–2,800	25–29	Sugar maple, red and white pines, Norway and red spruces, European larch.
Kars fine sandy loam, 3 to 8 percent slopes	2	NH	2,300–2,700	24–27	Same.
Kars fine sandy loam, 8 to 15 percent slopes	2	NH	2,300–2,700	24–27	Same.
Kars fine sandy loam, 15 to 25 percent slopes	2	NH	2,300–2,700	24–27	Same.
Kars fine sandy loam, 25 to 50 percent slopes	2	NH	2,300–2,700	24–27	Same.

See footnotes at end of table.

TABLE 2.—*Estimated volume of timber per acre to be expected from fully stocked 50-year-old stands; site classes, existing forest types, and suitable species of trees for planting on each soil*—Continued

[Absence of figures indicates land type is not suited to trees]

Soils	Existing forests				Suitable species for planting
	Site class	Forest type [1]	Volume per acre [2]		
			Cubic feet	*Cords*	
Kendaia silt loam, 0 to 3 percent slopes	3	SH-NH	2,400-2,800	25-28	Norway, white, and red spruces, white pine, whitecedar, European larch.[6]
Kendaia silt loam, 3 to 8 percent slopes	3	SH-NH	2,400-2,800	25-28	Same.
Kendaia very stony silt loam, 0 to 3 percent slopes	3	SH-NH	2,400-2,800	25-28	Same.
Kendaia very stony silt loam, 3 to 8 percent slopes	3	SH-NH	2,400-2,800	25-28	Same.
Livingston silty clay loam, 0 to 3 percent slopes	4	SH	1,400-1,800	12-16	Possibly whitecedar.
Lyons silt loam, 0 to 3 percent slopes	4	SH	1,400-1,800	12-16	Possibly whitecedar.
Lyons very stony silt loam, 0 to 3 percent slopes	4	SH	1,400-1,800	12-16	Possibly whitecedar.
Melrose fine sandy loam, 0 to 3 percent slopes	2	NH	2,400-2,800	24-28	Sugar maple, red and white pines, Norway and red spruces, European larch.
Melrose fine sandy loam, 3 to 8 percent slopes	2	NH	2,400-2,800	24-28	Same.
Melrose fine sandy loam, 8 to 15 percent slopes	2	NH	2,400-2,800	24-28	Same.
Melrose fine sandy loam, 15 to 25 percent slopes	2	NH	2,400-2,800	24-28	Same.
Nellis silt loam, 0 to 3 percent slopes	1	NH	3,200-3,600	30-34	Norway, white, and red spruces, sugar maple, red and white pines, European larch, whitecedar.
Nellis silt loam, 3 to 8 percent slopes	1	NH	3,200-3,600	30-34	Same.
Nellis silt loam, 8 to 15 percent slopes	1	NH	3,200-3,600	30-34	Same.
Nellis silt loam, 15 to 25 percent slopes	1	NH	3,200-3,600	30-34	Same.
Nellis very stony silt loam, 0 to 3 percent slopes	1	NH	3,200-3,600	30-34	Same.
Nellis very stony silt loam, 3 to 8 percent slopes	1	NH	3,200-3,600	30-34	Same.
Nellis very stony silt loam, 8 to 15 percent slopes	1	NH	3,200-3,600	30-34	Same.
Nellis very stony silt loam, 15 to 25 percent slopes	1	NH	3,200-3,600	30-34	Same.
St. Albans-Dutchess loams, 3 to 8 percent slopes	2	NH	2,500-2,900	24-28	Norway, white, and red spruces, sugar maple, red and white pines, European larch.
St. Albans-Dutchess rocky loams, 3 to 8 percent slopes.	[5] 2	NH	2,500-2,900	24-28	Red and white pines, sugar maple, Norway spruce.[4]
St. Albans-Dutchess rocky loams, 8 to 15 percent slopes.	[5] 2	NH	2,500-2,900	24-28	Same.
St. Albans-Dutchess very rocky loams, 3 to 8 percent slopes.	2	NH	2,200-2,900	22-28	Usually survival is too poor to warrant planting. Red pine might grow.
St. Albans-Dutchess very rocky loams, 15 to 25 percent slopes.	2	NH	2,200-2,900	22-28	Same.
Swanton fine sandy loam, 0 to 3 percent slopes	3	SH-NH	2,100-2,400	16-20	Norway, white, and red spruces, white pine, whitecedar, European larch.[6]
Swanton fine sandy loam, 3 to 8 percent slopes	3	SH-NH	2,100-2,400	16-20	Same.
Vergennes silty clay loam, 0 to 3 percent slopes	2	NH	2,200-2,600	21-25	Norway, white, and red spruces, red and white pines, sugar maple, European larch, whitecedar.
Vergennes silty clay loam, 3 to 8 percent slopes	2	SH-NH	2,200-2,600	21-25	Same.
Whately loam, 0 to 3 percent slopes	4	SH	1,400-1,800	12-16	Possibly whitecedar.

[1] NH: Northern hardwood or a mixture of the Northern hardwood and Oak-hickory types. Among the trees are sugar maple, beech, white ash, red oak, and shagbark hickory. SH: Swamp hardwoods. Trees included are red maple, American elm, poplar, yellow birch, and black ash. SH-NH: Mixture of SH and NH but predominantly SH. Red maple and American elm are common. The composition of each forest type varies somewhat with each soil series.

[2] Total volume of individual trees is computed to a 3-inch top.

[3] Many black spruce and tamarack grow on this soil.

[4] Planted seedlings may die from drought the first year.

[5] In areas where the soil is 12 to 14 inches deep, the site could change from 2 to 1.

[6] Seedlings may die on this soil. If possible, plant on hummocks or on top of plowed furrow.

TABLE 3.—*Land use, approximate acreage, and proportionate extent of the soils mapped*

Soils	Land use				Total	Proportion
	Cropland	Pasture-land	Woodland	Idle land and other [1]		
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Percent*
Amenia silt loam, 0 to 3 percent slopes	1,464	433	22	100	2,019	4.1
Amenia silt loam, 3 to 8 percent slopes	2,048	870	103	400	3,421	6.9
Amenia silt loam, 8 to 15 percent slopes	50	40	14	7	111	.2
Amenia very stony silt loam, 0 to 3 percent slopes	0	82	91	5	178	.4
Amenia very stony silt loam, 3 to 8 percent slopes	1	399	332	15	747	1.5
Amenia very stony silt loam, 8 to 15 percent slopes	0	21	21	1	43	.1
Balch peat	0	1	502	4	507	1.0
Beach and dune sand	0	21	23	108	152	.3
Benson rocky loam, over massive limestone, 0 to 3 percent slopes	19	5	0	0	24	(2)
Benson rocky loam, over massive limestone, 3 to 8 percent slopes	278	142	35	58	513	1.0
Benson rocky loam, over massive limestone, 8 to 15 percent slopes	23	43	10	0	76	.2
Benson very rocky loam, over massive limestone, 0 to 3 percent slopes	0	29	0	0	29	.1
Benson very rocky loam, over massive limestone, 3 to 8 percent slopes	48	750	445	107	1,350	2.7
Benson very rocky loam, over massive limestone, 8 to 15 percent slopes	12	254	221	79	566	1.1
Benson very rocky loam, over massive limestone, 15 to 25 percent slopes	0	80	48	2	130	.3
Benson very rocky loam, over massive limestone, 25 to 35 percent slopes	0	29	20	12	61	.1
Benson rocky silt loam, over shaly limestone, 0 to 3 percent slopes	126	28	1	2	157	.3
Benson rocky silt loam, over shaly limestone, 3 to 8 percent slopes	3,054	1,194	305	436	4,989	10.1
Benson rocky silt loam, over shaly limestone, 8 to 15 percent slopes	1,416	749	247	237	2,649	5.4
Benson rocky silt loam, over shaly limestone, 15 to 25 percent slopes	234	401	198	62	895	1.8
Benson rocky silt loam, over shaly limestone, 25 to 35 percent slopes	16	40	17	10	83	.2
Benson rocky silt loam, over shaly limestone, 35 to 50 percent slopes	8	49	12	3	72	.1
Benson very rocky silt loam, over shaly limestone, 3 to 8 percent slopes	0	12	17	2	31	.1
Benson very rocky silt loam, over shaly limestone, 8 to 15 percent slopes	1	35	33	3	72	.1
Benson very rocky silt loam, over shaly limestone, 15 to 25 percent slopes	0	24	0	0	24	(2)
Benson very rocky silt loam, over shaly limestone, 25 to 50 percent slopes	0	10	4	0	14	(2)
Carlisle muck	1	150	2,775	217	3,143	6.4
Covington silty clay loam, 0 to 3 percent slopes	5,679	3,921	1,039	732	11,371	23.1
Covington silty clay loam, 3 to 8 percent slopes	305	146	36	52	539	1.1
Elmwood fine sandy loam, 0 to 3 percent slopes	285	111	39	4	439	.9
Elmwood fine sandy loam, 3 to 8 percent slopes	142	94	13	11	260	.5
Fresh water marsh	0	3	77	165	245	.5
Kars fine sandy loam, 0 to 3 percent slopes	142	69	52	11	274	.6
Kars fine sandy loam, 3 to 8 percent slopes	543	179	64	78	864	1.8
Kars fine sandy loam, 8 to 15 percent slopes	53	43	3	29	128	.3
Kars fine sandy loam, 15 to 25 percent slopes	0	0	10	0	10	(2)
Kars fine sandy loam, 25 to 50 percent slopes	2	1	5	0	8	(2)
Kendaia silt loam, 0 to 3 percent slopes	2,493	1,441	141	142	4,217	8.6
Kendaia silt loam, 3 to 8 percent slopes	191	149	4	15	359	.7
Kendaia very stony silt loam, 0 to 3 percent slopes	10	982	670	106	1,768	3.6
Kendaia very stony silt loam, 3 to 8 percent slopes	1	58	35	2	96	.2
Livingston silty clay loam, 0 to 3 percent slopes	29	570	644	149	1,392	2.8
Lyons silt loam, 0 to 3 percent slopes	9	18	17	3	47	.1
Lyons very stony silt loam, 0 to 3 percent slopes	0	60	32	0	92	.2
Melrose fine sandy loam, 0 to 3 percent slopes	51	11	1	0	63	.1
Melrose fine sandy loam, 3 to 8 percent slopes	36	14	27	0	77	.2
Melrose fine sandy loam, 8 to 15 percent slopes	2	6	1	0	9	(2)
Melrose fine sandy loam, 15 to 25 percent slopes	0	1	7	0	8	(2)
Nellis silt loam, 0 to 3 percent slopes	72	20	0	0	92	.2
Nellis silt loam, 3 to 8 percent slopes	798	196	39	35	1,068	2.2
Nellis silt loam, 8 to 15 percent slopes	175	45	17	9	246	.5
Nellis silt loam, 15 to 25 percent slopes	26	18	7	0	51	.1
Nellis very stony silt loam, 0 to 3 percent slopes	0	13	5	0	18	(2)
Nellis very stony silt loam, 3 to 8 percent slopes	1	58	121	15	195	.4

See footnotes at end of table.

TABLE 3.—*Land use, approximate acreage, and proportionate extent of the soils mapped*—Continued

Soils	Land use				Total	Proportion
	Cropland	Pasture-land	Woodland	Idle land and other [1]		
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Percent*
Nellis very stony silt loam, 8 to 15 percent slopes	0	48	34	0	82	0.2
Nellis very stony silt loam, 15 to 25 percent slopes	0	5	22	0	27	.1
St. Albans-Dutchess loams, 3 to 8 percent slopes	0	0	3	6	9	(2)
St. Albans-Dutchess rocky loams, 3 to 8 percent slopes	0	0	138	195	333	.7
St. Albans-Dutchess rocky loams, 8 to 15 percent slopes	0	0	13	20	33	.1
St. Albans-Dutchess very rocky loams, 3 to 8 percent slopes	0	0	0	10	10	(2)
St. Albans-Dutchess very rocky loams, 15 to 25 percent slopes	0	0	10	1	11	(2)
Swanton fine sandy loam, 0 to 3 percent slopes	1,013	757	271	44	2,085	4.2
Swanton fine sandy loam, 3 to 8 percent slopes	95	77	51	13	236	.5
Vergennes silty clay loam, 0 to 3 percent slopes	64	10	0	16	90	.2
Vergennes silty clay loam, 3 to 8 percent slopes	109	42	1	0	152	.3
Whately loam, 0 to 3 percent slopes	7	58	113	8	186	.4
Water [3]	0	0	0	34	34	.1
Total	21,132	15,115	9,258	3,775	49,280	100.0

[1] "Idle land" is land not used for farming, and no commercial species of trees grow on it. "Other" includes land used for cemeteries, gravel pits, homesteads, and quarries.

[2] Less than 0.1 percent.

[3] Includes acreage of one creek and some ponds.

Typical profile (Amenia silt loam, 3 to 8 percent slopes):

0 to 7 inches—
Very dark brown silt loam that has a granular structure.

7 to 14 inches—
Brown to dark-brown silt loam that has a well-developed granular structure and is slightly acid (pH 6.5).

14 to 25 inches—
Very dark grayish-brown silt loam mottled with olive brown. Soil particles cling together in fairly well developed, slightly rounded blocks ⅛ to ½ inch in diameter. Most of this layer is slightly acid. The pH is 6.5 in most places, but in some places it is 7.5 or higher.

25 inches+—
Dark-gray silt loam with many olive-brown mottles. Soil particles form fairly well developed, slightly rounded blocks ⅛ to ½ inch in diameter. In some areas, soil particles form well-developed plates, 1/16 to ½ inch thick, that are hard in place and difficult to dig through with a spade. This layer is alkaline (pH higher than 7.5).

Variations.—In some places the depth to the limestone bedrock is between 1½ and 3 feet, but in most places it is more than 3 feet. The depth to the dark-gray alkaline layer is less than 30 inches in most places but ranges up to more than 40 inches. In some areas the surface soil and subsoil contain a little more clay than the soil described for the series, and in other places they contain a little more sand. The underlying material is a little more clayey in places.

Additional facts.—The uppermost 14 inches is granular and crumbly. Water passes through it readily. Unless the soil is soaking wet, water moves fairly well through the layer between 14 inches and 25 inches. Nevertheless, these soils are wet and seepy because water moves slowly through the denser material below 25 inches.

These soils are wet early in spring and often late in spring and at times in fall. Except for some bothersome wet spots, the soils are not so wet that they need artificial drainage to make them suitable for hay or pasture plants.

Amenia silt loam, 0 to 3 percent slopes (AaA), is more poorly drained than Amenia silt loam, 3 to 8 percent slopes. It is, consequently, slightly more mottled with olive brown in the lower subsoil. In some areas the mottling is nearer the surface.

Capability.—Class II, subclass IIw, and management group 3. Wetness is the major problem. This soil is subject to little or no erosion.

Suitable uses and management needs.—Hay, silage corn, small grains, and pasture plants are suited to this soil. Ladino clover is especially well suited. Wet spots can be drained by tile. Corn and alfalfa are not so well suited to this slightly wet soil as to the better drained Nellis soils. Internal drainage, preferably by tile, is needed to insure high yields of corn and alfalfa.

Amenia silt loam, 3 to 8 percent slopes (AaB), is the soil described as typical of the Amenia series. It is slightly eroded in some areas. Included with it are small areas that are strongly acid to depths of 18 to 30 inches. Most of these acid areas are on the small uninhabited islands in the eastern part of the county.

Capability.—Class II, subclass IIw, and management group 3. Wetness is the major problem. The soil is somewhat erodible.

Suitable uses and management needs.—The crops suited to Amenia silt loam, 0 to 3 percent slopes, are suited to this soil. Alfalfa, however, is not suitable for the included strongly acid areas.

This soil will erode when it is tilled, unless precautions are taken. Where possible, it should be worked across the slope in graded strips. On long slopes, it may need diversion terraces to intercept and carry off excess surface water. In places it may also need tile or interception drainage ditches to carry off subsurface water.

Amenia silt loam, 8 to 15 percent slopes (AaC), resembles Amenia silt loam, 3 to 8 percent slopes, but has a few small areas that are moderately eroded. Included with this soil are some complex slopes of 3 to 8 percent and some single slopes of 15 to 25 percent.

Capability.—Class III, subclass IIIe, and management group 5. Erosion is the major problem.

Suitable uses and management needs.—The same crops are suited to this soil as to Amenia silt loam, 0 to 3 percent

slopes. On these steeper, more complex slopes, it is more difficult to prevent erosion and to operate modern farm machinery than on Amenia silt loam, 3 to 8 percent slopes. Where possible, this soil should be worked across the slope in graded strips. On many of the longer slopes, diversion terraces are needed to intercept and carry off surface water. Tile drains or open ditches to intercept subsurface water would improve drainage.

Amenia very stony silt loam, 0 to 3 percent slopes (AbA), is too stony to be tilled.

Capability.—Class VI, subclass VIs, and management group 12. Stoniness is the major problem.

Suitable uses and management needs.—This soil is used for pasture and woodland. Sugar maple, white ash, and other desirable trees produce good yields of timber.

If more cropland or improved pasture is needed, it is practical to clear this soil of surface stones. If the stones are removed, this soil is suitable for the same crops and needs the same kind of management as Amenia silt loam, 0 to 3 percent slopes.

Amenia very stony silt loam, 3 to 8 percent slopes (AbB), is too stony to be tilled. Small areas that are strongly acid to depths of 18 to 30 inches are included with this soil. Most of these acid areas are on the small uninhabited islands in the eastern part of the county.

Capability.—Class VI, subclass VIs, and management group 12. Stoniness is the major problem.

Suitable uses and management needs.—This soil is used for pasture and woodland. It could be cleared of stones and used for crops or improved pasture. If surface stones are removed, this soil can be used and managed in the same way as Amenia silt loam, 3 to 8 percent slopes.

Amenia very stony silt loam, 8 to 15 percent slopes (AbC), is too stony to be tilled. Small areas that have slopes of 15 to 35 percent or more are included with this soil.

Capability.—Class VI, subclass VIs, and management group 12. Stoniness is the major problem.

Suitable uses and management needs.—This soil is suitable for the same uses as Amenia very stony silt loam, 0 to 3 percent slopes. If surface stones are removed so that the soil can be tilled, it can be used and managed in the same way as Amenia silt loam, 8 to 15 percent slopes.

Balch Peat

Balch peat is a brown, very wet, acid soil that is waterlogged or covered by water a large part of the year. It has formed from organic matter, mainly partly decomposed forest vegetation. It occurs in nearly level or depressed areas, chiefly on large flats. Practically all of it is in the southern end of the town of Alburg. The trees that grow here are mostly black spruce and tamarack. The stands contain some white pine and red maple.

Typical profile (Balch peat):

0 to 36 inches+—
Dark reddish-brown organic deposit, mostly partly decayed tree remains. This deposit is very acid (pH probably lower than 5.0).

Additional facts.—The organic deposits are generally at least 4 feet deep over clay or other mineral soil material. Few areas, if any, can be artificially drained because the soil occurs at the level of Lake Champlain or in such low places that there are no suitable outlets.

Balch peat (BaA) is the soil described as typical.

Capability.—Class VII, subclass VIIw, and management group 16. Extreme wetness is the major problem. Balch peat is not subject to erosion.

Suitable uses and management needs.—This soil is not suitable for crops and will not produce good trees for timber. Practically all of it is forested, but many 50-year-old spruce and tamarack trees are only 8 to 12 feet tall. It is best to leave the cleared areas to reseed naturally to forest. Possibly this area of Balch peat could be developed for muskrats or waterfowl.

Beach and Dune Sand

This land type consists of very droughty sands that were deposited by water and, in a few places, by wind. These sands are scattered throughout the county along the shore of Lake Champlain. They are mainly level to gently sloping, but they range from level to almost steep. Few trees grow in these areas.

Typical profile (Beach and dune sand):

0 to 24 inches+—
Grayish-brown coarse sand that is structureless; the particles do not cling together to form any kind of lumps or aggregates.

Variations.—Included in this mapping unit are many small areas of flat fragments of shale and limestone. These fragments have been worked and reworked by action of the waves of Lake Champlain, which deposited them along the shoreline. In some places, at depths of 2 feet or more, the sand deposits or rock fragments are underlain by clay, limestone bedrock or other materials. In a few places, the winds have blown the sands into small dunes.

Beach and dune sand (Bb) is the only mapping unit. It includes all areas, regardless of slope.

Capability.—Class VIII, subclass VIIIs, and management group 18. Extreme droughtiness and infertility are the major problems.

Suitable uses and management needs.—This land type is not suitable for cultivated crops, pasture, or forests. Many of the beaches are excellent places for swimming and picnicking. In a few places where the sand deposits are shallow over bedrock or other material, planted pine trees seem to be growing fairly well.

Benson Series

The Benson series consists of shallow, rocky, somewhat droughty to droughty soils that overlie limestone. In most areas the dark-gray limestone bedrock is soft and shattered, but in some places it is hard and massive. These soils have formed from high-lime materials deposited by glaciers or from the fragments weathered from the bedrock itself. The slopes are mostly gentle but range from nearly level to very steep.

The Benson soils are some of the most extensive soils in the county. Most areas are near or adjacent to the deep well-drained Nellis soils, the slightly wet Amenia soils, and the wet Kendaia and Covington soils. They occur throughout the county, generally in large rolling areas. The Benson soils that overlie hard massive limestone are mainly in the town of Isle La Motte; those that overlie soft shattered limestone occur thoroughout the county except in Isle La Motte.

The forest trees are mixed hardwoods, mainly sugar maple, beech, basswood, white ash, hickory, and white-

cedar. The stands contain some red oak, white birch, hophornbeam, white pine, redcedar, and hemlock trees.

Typical profile (Benson rocky silt loam, over shaly limestone, 3 to 8 percent slopes):

0 to 9 inches—
Very dark grayish-brown silt loam that has a very well developed granular structure. It contains some shaly limestone fragments up to 1 inch in length.

9 to 16 inches—
Dark yellowish-brown silt loam that contains many shaly limestone fragments up to 1 inch in length and some as much as 6 inches long. The soil particles cling together to form well-developed, slightly rounded blocks that are less than ¼ inch in diameter. This layer is neutral (pH 7.0).

16 to 21 inches—
Dark grayish-brown silt loam that contains many shaly limestone fragments ranging from 1 to 16 inches in length. This layer is alkaline (pH higher than 7.5).

21 inches+—
Soft, dark-gray, shaly limestone bedrock.

Variations.—Although the depth to bedrock generally ranges from 6 inches to 2½ feet, outcrops of bedrock are common. In many places these soils are alkaline throughout (pH higher than 7.5). Included are a few small areas of acid soils (pH lower than 6.0) that overlie slate or shale bedrock. Where the profile is less than 16 inches deep, the dark yellowish-brown second layer may be thinner than that described in the typical profile, and the dark grayish-brown third layer may be missing.

Additional facts.—These soils are high in lime. They rarely have a pH value lower than 6.5.

Water moves readily through the profile. Since the soils are generally less than 2 feet deep over bedrock, they are droughty. They dry out early in spring. Bedrock outcrops interfere with tillage. The plowpoint ordinarily will shatter the shaly limestone but not the massive limestone.

Benson rocky loam, over massive limestone, 0 to 3 percent slopes (BcA), contains more sand and fewer limestone fragments than Benson rocky silt loam, over shaly limestone, 3 to 8 percent slopes (described as typical). It is not extensive.

Capability.—Class II, subclass IIs, and management group 4. Rockiness and shallowness are the major problems.

Suitable uses and management needs.—This soil can be used for silage corn, small grains, hay, and improved pasture. It is generally too droughty for Ladino clover. Alfalfa does well where the depth to bedrock is at least 18 inches. The rock outcrops interfere with tillage.

Benson rocky loam, over massive limestone, 3 to 8 percent slopes (BcB), is the same as Benson rocky loam, over massive limestone, 0 to 3 percent slopes, except for having stronger slopes.

Capability.—Class II, subclass IIs, and management group 4. Rockiness and shallowness are the major problems, but erosion is also a problem.

Suitable uses and management needs.—This soil is suited to the same crops as Benson rocky loam, over massive limestone, 0 to 3 percent slopes. As this soil will erode when tilled, it should be worked across the slope in contour or field strips. Rock outcrops interfere with tillage.

Benson rocky loam, over massive limestone, 8 to 15 percent slopes (BcC), is similar to Benson rocky loam, over massive limestone, 0 to 3 percent slopes, but is probably somewhat shallower to bedrock. A few areas are slightly eroded. Included with this soil is a small area that has slopes of 15 to 25 percent.

Capability.—Class III, subclass IIIs, and management group 8. Rockiness and shallowness are the major problems, but erosion is also a problem.

Suitable uses and management needs.—This soil is suited to the same crops as Benson rocky loam, over massive limestone, 0 to 3 percent slopes, but rotations should be longer. As this soil will erode when tilled, it is best to work across the slope in contour strips or, if contouring is impractical, in field strips. Rock outcrops interfere with tillage. It is more difficult to control erosion and to operate modern farm machinery on this soil than on the less strongly sloping Benson rocky loams.

Benson very rocky loam, over massive limestone, 0 to 3 percent slopes (BdA), is too rocky (ledgy) to be tilled. The surface soil is only 3 to 7 inches deep. This soil is of small extent.

Capability.—Class VI, subclass VIs, and management group 13. Extreme rockiness and shallowness are the major problems.

Suitable uses and management needs.—This soil is only suitable for native pasture or trees. Native pasture is usually not very good because the soil is very shallow and dries out early in the growing season. The native pasture plants—Kentucky bluegrass, wild whiteclover, povertygrass, and weeds—provide forage of low quality.

Benson very rocky loam, over massive limestone, 3 to 8 percent slopes (BdB), is the same as Benson very rocky loam, over massive limestone, 0 to 3 percent slopes, except that the slopes are stronger.

Capability.—Class VI, subclass VIs, and management group 13. Extreme rockiness and droughtiness are the major problems.

Suitable uses and management needs.—This soil is suited to the same uses and needs the same management as Benson very rocky loam, over massive limestone, 0 to 3 percent slopes.

Benson very rocky loam, over massive limestone, 8 to 15 percent slopes (BdC), is the same as Benson very rocky loam, over massive limestone, 0 to 3 percent slopes, except that the slopes are stronger. A few small areas are slightly eroded.

Capability.—Class VI, subclass VIs, and management group 13. Extreme shallowness and droughtiness are the major problems.

Suitable uses and management.—This soil is suited to the same uses and needs the same management as Benson very rocky loam, over massive limestone, 0 to 3 percent slopes.

Benson very rocky loam, over massive limestone, 15 to 25 percent slopes (BdD), is probably shallower to bedrock than Benson very rocky loam, over massive limestone, 0 to 3 percent slopes. A few small areas are slightly eroded.

Capability.—Class VI, subclass VIs, and management group 13. Extreme shallowness and droughtiness are the major problems.

Suitable uses and management needs.—This soil is suited to the same uses and needs the same management as Benson very rocky loam, over massive limestone, 0 to 3 percent slopes.

Benson very rocky loam, over massive limestone, 25 to 35 percent slopes (BdE), has more bedrock outcrops than Benson very rocky loam, over massive limestone, 0 to 3 percent slopes. Some small areas are slightly eroded. Included with this soil are small areas that have slopes of 35 to 60 percent.

Capability.—Class VII, subclass VIIs, and management group 17. Extreme shallowness and droughtiness are the major problems.

Suitable uses and management needs.—Neither crops nor pasture are suitable for this soil, which cannot economically be improved so that it could be used for either. This soil should be used only as woodland or as wildlife refuges.

Benson rocky silt loam, over shaly limestone, 0 to 3 percent slopes (BeA), is the same as the soil described as typical of the series, except that the slopes are milder.

Capability.—Class II, subclass IIs, and management group 4. Rockiness and shallowness are the major problems.

Suitable uses and management needs.—Hay, silage corn, small grains, pasture plants, and other crops grown locally are suited to this soil. Alfalfa and corn do best where the soil is at least 18 inches deep. Although this soil is rather shallow, there is a fairly deep rooting zone because the roots penetrate the many cracks in the soft, shattered limestone. The rock outcrops interfere with tillage, but ordinarily the plowpoint will shatter the shaly limestone wherever it outcrops.

Benson rocky silt loam, over shaly limestone, 3 to 8 percent slopes (BeB), is the soil described as typical of the Benson series. Included in this mapping unit are some small areas that are slightly eroded and a few that are severely eroded.

Capability.—Class II, subclass IIs, and management group 4. Rockiness and shallowness are the major problems. Erosion is also a problem.

Suitable uses and management needs.—The same crops are suitable for this soil as for Benson rocky silt loam, over shaly limestone, 0 to 3 percent slopes. More alfalfa is grown on this soil than on any other in the county. Because this soil will erode when tilled, it should be worked across the slope in contour strips or, if that is impracticable, in field strips. Rock outcrops interfere with tillage.

Benson rocky silt loam, over shaly limestone, 8 to 15 percent slopes (BeC), is slightly eroded in places. Included with this soil are many areas that have broken slopes of 3 to 8 percent.

Capability.—Class III, subclass IIIs, and management group 8. Rockiness and shallowness are the major problems, but erosion is also a problem.

Suitable uses and management needs.—The same crops are suitable for this soil as for Benson rocky silt loam, over shaly limestone, 0 to 3 percent slopes, but the rotation should be longer. If precautions are not taken, this soil will erode when it is tilled. It should be worked across the slope in contour strips or, if contouring is not practicable, in field strips. The rock outcrops interfere with tillage.

Benson rocky silt loam, over shaly limestone, 15 to 25 percent slopes (BeD), probably has more areas of shallow soil and exposed bedrock than Benson rocky silt loam, over shaly limestone, 3 to 8 percent slopes. Most of this mapping unit is on complex slopes. Some areas are slightly eroded. Included with this soil are many areas that have complex slopes of 8 to 15 percent.

Capability.—Class IV, subclass IVs, and management group 10. Rockiness and shallowness are the major problems. Erosion is also a problem.

Suitable uses and management needs.—Except for corn, the same crops are suitable for this soil as for Benson rocky silt loam, over shaly limestone, 0 to 3 percent slopes. This soil is too strongly sloping and too ledgy to be cultivated. It is best to keep it in tall grasses and legumes that can be used for rotation hay and pasture. Ladino clover is short lived because of droughtiness. Deeper rooted grasses and legumes, however, do fairly well. Early spring pasture is excellent.

This soil should be plowed only when it is necessary to reseed it. It will erode when plowed, so it should be worked across the slope in contour strips or, if contouring is not practicable, in field strips. The strong, complex slopes make it difficult to conserve this soil and to use modern farm machinery.

Benson rocky silt loam, over shaly limestone, 25 to 35 percent slopes (BeE), is probably shallower and has more exposed bedrock than Benson rocky silt loam, over shaly limestone, 3 to 8 percent slopes.

Capability.—Class VII, subclass VIIe, and management group 15. This soil is rocky and shallow, and erosion and difficulty of tilling are the major problems.

Suitable uses and management needs.—This soil should be used only for forests or for wildlife refuges. It should be protected from grazing.

Benson rocky silt loam, over shaly limestone, 35 to 50 percent slopes (BeF), is shallower and has more exposed bedrock than Benson rocky silt loam, over shaly limestone, 3 to 8 percent slopes. Some areas are slightly eroded, and a few are severely eroded.

Capability.—Class VII, subclass VIIe, and management group 15. Although this soil is rocky and shallow, the erosion hazard is the major problem.

Suitable uses and management needs.—This soil should be used only for forests or for wildlife refuges. It should be protected from grazing.

Benson very rocky silt loam, over shaly limestone, 3 to 8 percent slopes (BfB), is too rocky to be tilled. Included with this soil are a few small areas that have slopes of 1 to 3 percent.

Capability.—Class VI, subclass VIs, and management group 13. Extreme rockiness and shallowness are the major problems.

Suitable uses and management needs.—This soil should be used only for native pasture or trees. The native pasture is not very good, because the soil dries out early in the year. It produces low-quality roughage consisting of povertygrass, Kentucky bluegrass, wild whiteclover, and weeds.

Benson very rocky silt loam, over shaly limestone, 8 to 15 percent slopes (BfC), is more strongly sloping than Benson very rocky silt loam, over shaly limestone, 3 to 8 percent slopes, but is otherwise the same.

Capability.—Class VI, subclass VIs, and management group 13. Extreme rockiness and shallowness are the major problems.

Suitable uses and management needs.—This soil is suitable for the same uses and needs the same kind of management as Benson very rocky silt loam, over shaly limestone, 3 to 8 percent slopes.

Benson very rocky silt loam, over shaly limestone, 15 to 25 percent slopes (BfD), is much more strongly sloping than Benson very rocky silt loam, over shaly limestone, 3 to 8 percent slopes, but is otherwise the same.

Capability.—Class VI, subclass VIs, and management group 13. Extreme rockiness and shallowness are the major problems.

Suitable uses and management needs.—This soil is suitable for the same uses and needs the same kind of man-

agement as Benson very rocky silt loam, over shaly limestone, 3 to 8 percent slopes.

Benson very rocky silt loam, over shaly limestone, 25 to 50 percent slopes (BfE), is shallower and has more exposed bedrock than Benson very rocky silt loam, over shaly limestone, 3 to 8 percent slopes.

Capability.—Class VII, subclass VIIs, and management group 17. Extreme rockiness and shallowness are the major problems.

Suitable uses and management needs.—This soil should be used only for trees or wildlife. It should be protected from grazing. It cannot economically be improved so that it would be suitable for pasture.

Carlisle Muck

Carlisle muck is a very wet, black soil that is waterlogged or covered by water a large part of the year. It has formed from organic matter, mainly decomposed forest vegetation. It occurs in level or depressed areas on large flats throughout the county. Most of it is in the town of Alburg. The forested areas contain swamp trees—chiefly elm, red maple, yellow birch, poplar, and whitecedar.

Typical profile (Carlisle muck):

0 to 9 inches—
Black, well-decomposed mucky layer that has a good granular structure. It is neutral (pH 7.0).

9 to 40 inches—
Black, well-decomposed organic matter that contains some partially decomposed tree remains. The organic materials do not group together to form any kind of structure. This layer is neutral (pH 7.0).

40 inches +—
Dark-gray silt loam that is slightly sticky when wet. It is neutral (pH 7.0).

Additional facts.—The organic deposits are generally 2 to 4 feet thick over mineral soil, usually clay. On the larger flats the organic deposits are deep, and in the smaller areas they are shallow. Few stones, if any, occur on this soil. Hardly any of this soil can be artificially drained because it occurs at lake level or in such low places that there are no drainage outlets.

Carlisle muck (CaA) is the soil described as typical. It is the only mapping unit of the series.

Capability.—Class VII, subclass VIIw, and management group 16. Extreme wetness is the major problem. Carlisle muck is not subject to erosion.

Suitable uses and management needs.—Unless this soil is drained, none of the crops grown locally are suitable for it. Cattails, alders, willows, rushes, and other water-tolerant plants grow in most of the cleared areas. Reed canarygrass would probably do well if seeded during a dry summer. Some areas of this soil can be developed as habitats for waterfowl.

Covington Series

The Covington series consists of dark-colored clay soils. In most years they are wet for a long time in spring and fall. These soils have formed from clays and silts that were deposited in inland seas. They are mainly level or nearly level, but some are gently sloping. They occur throughout the county on broad flats and in pockets between ridges.

The Covington soils are the most extensive in the county. Many areas lie near or adjacent to Vergennes and Livingston soils. Vergennes soils are better drained and Livingston soils are more poorly drained than the Covington soils.

The forests consist of red maple, American elm, white ash, and whitecedar. Some yellow birch, black ash, white pine, and hemlock are also in the stands.

Typical profile (Covington silty clay loam, 0 to 3 percent slopes):

0 to 7 inches—
Very dark grayish-brown to very dark gray silty clay loam that has a good granular structure but is sticky when wet and hard when dry.

7 to 35 inches—
Dark-gray to dark-brown heavy clay with many brown and dark yellowish-brown mottles caused by surplus water that stands in the soil a good part of the year. In most places the amount of mottling decreases with depth. The clay particles cling together to form well-developed blocks that range in diameter from ⅛ to ½ inch. Most of the blocks have angular corners, but some are slightly rounded. In places in the lower part of this layer the blocks are coated with a dark-gray film. This layer is neutral (pH 7.0).

35 inches +—
Dark grayish-brown heavy clay mottled with yellowish brown, olive brown, and dark gray. The clay particles form fairly well developed plates that range from ⅛ inch to more than ½ inch in thickness. In most places the pH value is about 7.0, but in some places it is higher than 7.5.

Variations.—The surface layer generally has a clayey feel, but in places it contains more sand and has a fine sandy loam texture. The soils of this series are normally deep, but in places they are shallow (2 to 3 feet) over glacial deposits, limestone bedrock, or sandy material. Some areas contain a few stone fragments.

Additional facts.—The surface layer is fairly easy to work if the content of moisture is right, but most of the time it is difficult to work. Water moves slowly through the subsoil.

Covington soils are productive but need artificial drainage. They are high in organic matter. They do not need so much potash as sandy and gravelly soils, and some areas do not need lime.

Covington silty clay loam, 0 to 3 percent slopes (CbA), the soil described as typical of the Covington series, is the most extensive soil in the county. It is not eroded.

Capability.—Class III, subclass IIIw, and management group 7. Wetness is the major problem.

Suitable uses and management needs.—This soil is productive, but it needs to be drained by tile or ditches. It can be used for silage corn, small grains, hay, and improved pasture. If drained by complete systems of tile it is suitable for corn and alfalfa, but these crops do not grow well in areas that are undrained or partially drained by open ditches. Filling in depressions would improve surface drainage. Crops will grow faster if a topdressing of fertilizer high in nitrate nitrogen is applied early in the spring.

Covington silty clay loam, 3 to 8 percent slopes (CbB), has lost some of its surface soil through erosion. The slopes range from 3 to 8 percent but are dominantly 3 to 5 percent. Included with this soil are a few areas that have slopes ranging from 15 to 25 percent.

Capability.—Class III, subclass IIIw, and management group 7. Although this soil is erodible, wetness is the major problem.

Suitable uses and management needs.—This soil is suited to the same crops as Covington silty clay loam, 0 to 3

percent slopes. It needs supplemental drainage. Few areas are drained by a complete system of tile. The slopes are strong enough for tile to carry off excess water readily. To prevent erosion, this soil should be worked across the slope in graded strips. Diversion terraces may be needed to intercept excess water. Crops will grow faster if a topdressing of fertilizer high in nitrate nitrogen is applied early in the spring.

Dutchess Series

In Grand Isle County, soils of the Dutchess series are mapped only in the St. Albans-Dutchess complex. The Dutchess soils have formed from acid slaty or shaly material deposited by glaciers. They are normally strongly acid throughout. In color, texture, and structure, they are about the same as the St. Albans soils. The mapping units in which these soils occur are described under the St. Albans series.

Elmwood Series

The Elmwood series consists of slightly wet sandy soils underlain by clay at depths of 1 to 4 feet. These soils have a brown to yellowish-brown sandy subsoil that is mottled with bright colors in the lower part. They have formed from water-laid sands. They are mostly nearly level, but they range from level to gently sloping.

Elmwood soils occur throughout the county, generally in small areas. Most areas lie near or adjacent to the somewhat droughty Kars soils, the well-drained Melrose soils, and the wet Swanton soils. The trees of the forested areas are mixed hardwoods, such as sugar maple, beech, red maple, red oak, white oak, elm, gray birch, white pine, and hemlock.

Typical profile (Elmwood fine sandy loam, 0 to 3 percent slopes):

0 to 4 inches—
Very dark brown granular fine sandy loam. In plowed areas, this layer is 7 to 11 inches thick and is brown to dark brown.

4 to 10 inches—
Brown to dark yellowish-brown fine sandy loam. Soil particles cling together to form weakly developed blocks that are slightly rounded and that range in diameter from ¼ to ¾ inch. This layer is strongly acid (pH 5.5).

10 to 15 inches—
Yellowish-brown sandy layer with a few dark-red and dark reddish-brown mottles that range in diameter from ⅛ to ½ inch. Mottling is caused by seepage water in spring and fall. Soil particles cling together to form weakly developed blocks that are slightly rounded and that range in diameter from ⅜ to ¾ inch. This layer is strongly acid (pH 5.2).

15 to 31 inches—
Grayish-brown to dark grayish-brown friable sandy layer with many dark reddish-brown and yellowish-brown mottles that are more than ½ inch across. The soil particles cling together to form weakly developed blocks that are slightly rounded and that range in diameter from ⅛ inch to nearly ½ inch. This layer is less acid than the layers above (pH 5.6).

31 inches+—
Gray clay that has many brown mottles. Clay particles cling together to form weakly developed plates ⅛ to ⅜ inch thick. When crushed in the hand, these plates break into slightly rounded blocks. This layer is slightly acid (pH 6.2).

Variations.—Depth to the clay layer ranges from 1 to more than 4 feet, but generally is 2 to 2½ feet.

Additional facts.—These soils are easy to work but are often wet late in spring. When the soil is not saturated, water moves rapidly through the sand layers and slowly through the clay layer. In wet years a perched water table forms, and the water moves slowly along the top of the clay layer. This usually restricts the growth of plant roots and reduces yields.

Elmwood soils respond well to lime and fertilizer. They generally require more than loamy and clayey soils. They especially need potash. They are too wet to be tilled early in spring, and in some years they are wet until late in spring. Wetness delays harvesting of corn in some years. Most of the soils in the Elmwood series, however, do not need artificial drainage to grow most hay and pasture plants.

Elmwood fine sandy loam, 0 to 3 percent slopes (EaA), is the soil described as typical for the Elmwood series. It is not eroded.

Capability.—Class II, subclass IIw, and management group 3. Slight wetness is the major problem.

Suitable uses and management needs.—This soil can be used for hay, silage corn, small grains, and improved pasture. It is especially good for Ladino clover. If it is drained, corn can be grown successfully. It can be used to grow alfalfa if drained, limed, and fertilized. Open ditches do a very effective job of draining this soil. Tile is good for draining wet spots.

Elmwood fine sandy loam, 3 to 8 percent slopes (EaB), is slightly eroded in spots. Included are a few small areas that have slopes ranging from 8 to 15 percent.

Capability.—Class II, subclass IIw, and management group 3. Slight wetness is the major problem. Erosion is also a problem.

Suitable uses and management needs.—The crops suited to Elmwood fine sandy loam, 0 to 3 percent slopes, are suited to this soil. Where possible, this soil should be worked across the slope in graded strips to prevent erosion. Ditches or tile may be needed to intercept seepage water. To be effective, these drains should be in the clay layer.

Fresh Water Marsh

Fresh water marsh (FaA) is a land type that is covered by shallow water most of the year. It occurs throughout the county along the shore of Lake Champlain. Marsh grasses and various rushes are the only plants that grow in these areas—trees rarely become established. Included in this mapping unit are some areas of very wet mineral soils that are covered with water a good part of the year. These areas are usually adjacent to and at the level of Lake Champlain. In places trees grow in them. When the water is low in the summer and fall, some areas of Fresh water marsh are not under water.

Fresh water marsh is in capability class VIII, subclass VIIIw, and management group 18. It is useful only as a refuge for waterfowl, muskrats, and other wildlife. Ducks, especially black ducks and mallards, find these areas good feeding grounds in the fall.

Kars Series

The Kars series consists of brown, somewhat droughty, deep sandy and gravelly soils. They have formed from sands and gravels that are high in natural lime. These soils tend to be slightly droughty but in most years are

neither very wet nor very dry. The slopes are dominantly gentle but range from nearly level to steep. Kars soils occur throughout the county but are most common near the village of Isle La Motte. Most areas are next to or near the well-drained Melrose soils and the slightly wet Elmwood soils. The forest trees are sugar maple, beech, white ash, basswood, red oak, white pine, and whitecedar.

Typical profile (Kars fine sandy loam, 3 to 8 percent slopes):

0 to 9 inches—
Dark-brown fine sandy loam that has a fairly well developed granular structure.

9 to 35 inches—
Brown to dark yellowish-brown friable loamy fine sand that grades to gravelly loamy sand with depth. The sandy particles cling together to form a weakly developed granular structure. This layer is neutral (pH 6.6).

35 to 40 inches—
Very dark brown to black gravelly clay loam. Soil particles cling together to form fairly well developed, slightly rounded blocks that range in diameter from ⅛ to ⅜ inch. This layer is less friable than the layers above and below. It is alkaline (pH 7.5+).

40 inches+—
Very dark gray, loose, structureless sandy and gravelly layers. The material falls apart easily when disturbed. The pebbles are mostly ¼ inch to 2 inches in diameter, but some 4- and 6-inch cobbles do occur. This deposit is alkaline (pH 7.5+).

Variations.—Depths to the sand and gravel layers range from 2 to more than 5 feet. In places the first three layers are more acid than those in the typical profile, the pH value being 6.0 or less. In other areas the upper three layers are sandier than those described and have a loamy sand texture.

Additional facts.—Water moves rapidly through the uppermost 35 to 40 inches and very rapidly through the layer of sand and gravel. The sandy texture and the rapid movement of water make these soils easy to work. They dry out early in spring. Plant foods move out of the root zone faster than in loamy or clayey soils.

Kars fine sandy loam, 0 to 3 percent slopes (KaA), is like the soil described as typical of the Kars series but is more gently sloping.

Capability.—Class I and management group 1. This soil is not liable to erode. Management problems are minor.

Suitable uses and management needs.—This soil can be used for silage corn, small grains, hay, and improved pasture. It is especially well suited to corn. Many areas are too droughty for Ladino clover. In places where the depth to high-lime material is 4 feet or more, alfalfa and row crops normally require extra lime and fertilizer. Manure will help to build fertility and to increase the water-holding capacity.

Kars fine sandy loam, 3 to 8 percent slopes (KaB), is the soil described as typical for the Kars series.

Capability.—Class II, subclass IIe, and management group 2. Erosion is the major problem.

Suitable uses and management needs.—This soil is suited to the same crops as Kars fine sandy loam, 0 to 3 percent slopes, but the rotations should be longer. It is likely to erode if it is tilled. Wherever possible, it should be worked across the slope in contour strips to prevent erosion. On the longer slopes diversion terraces may be needed to intercept and carry off surplus water. Manure will help to increase the fertility and improve the water-holding capacity. Generally, crops respond well to lime and fertilizer.

Kars fine sandy loam, 8 to 15 percent slopes (KaC), is moderately eroded in some areas. Included in this mapping unit is a very small area that is severely eroded.

Capability.—Class III, subclass IIIe, and management group 6. Erosion is the major problem.

Suitable uses and management needs.—This soil is suited to the same crops as Kars fine sandy loam, 0 to 3 percent slopes, but the rotations should be longer. It is more difficult to control erosion and to operate modern farm machinery on this soil than on Kars soils that have milder slopes. Where possible, this soil should be worked across the slope in contour strips. On the longer slopes diversion terraces may be needed to intercept and carry off surplus surface water.

Kars fine sandy loam, 15 to 25 percent slopes (KaD), is not extensive in this county. It is somewhat droughtier than Kars fine sandy loam, 3 to 8 percent slopes.

Capability.—Class IV, subclass IVe, and management group 9. Erosion is the major problem.

Suitable uses and management needs.—This soil is suited to the same crops as Kars fine sandy loam, 0 to 3 percent slopes, but the rotations should be longer. Steep slopes limit the use of this soil to hay or improved pasture. This soil should be plowed only when the hayfields or pastures have to be reseeded and should be plowed across the slope in contour strips. Fertilizer should be applied frequently to keep the hayfields and pastures productive as long as possible. This soil is excellent for early spring pasture.

Kars fine sandy loam, 25 to 50 percent slopes (KaE), is much droughtier than Kars fine sandy loam, 3 to 8 percent slopes. A few small areas are moderately eroded. Only a little of this soil is mapped in the county.

Capability.—Class VII, subclass VIIe, and management group 15. The erosion hazard is the major problem.

Suitable uses and management needs.—This soil is too steep to be cultivated and too dry to be used for native pasture. It should be planted to trees, preferably red pine or white pine. If grazed, it will erode readily.

Kendaia Series

The Kendaia series consists of wet, dark, loamy soils that have formed from high-lime materials left by glaciers. In most years these soils are wet for a long time in spring and fall. Because of the poor drainage, all of the subsoil is mottled. Most of this series is nearly level, but the range is from level to gently sloping. These soils occur on broad flats throughout the county; the largest areas are in the towns of Alburg and North Hero.

Most areas of Kendaia soils lie near or next to the droughty, shallow Benson soils, the slightly wet Amenia soils, and the very wet Lyons soils. The trees of the forested areas include elm, red maple, white ash, black ash, white pine, whitecedar, and some sugar maple and yellow birch.

Typical profile (Kendaia silt loam, 0 to 3 percent slopes):

0 to 6 inches—
Very dark gray silt loam that generally has a good granular structure. It is neutral (pH generally about 7.0).

6 to 16 inches—
Dark grayish-brown loam with many yellowish-brown and olive-brown mottles. In the upper part of this layer the soil particles cling together to form weakly developed, slightly rounded blocks that are less than ¼ inch in

diameter; in the lower part they form weakly developed plates that are about 1/16 inch thick. This layer is neutral. The pH value is generally about 7.0 but in some places is higher than 7.5.

16 to 23 inches—
Dark grayish-brown loam with a few olive-brown mottles. The soil particles form fairly well developed plates that are about 1/16 inch thick. This layer is alkaline (pH higher than 7.5).

23 inches+—
Dark grayish-brown loam with many yellowish-brown, olive-brown, and gray mottles. The soil particles form well-developed plates that are 1/16 inch thick. This layer is normally so hard it is difficult to dig through with a spade. It is alkaline (pH 7.5+).

Variations.—In some areas the depth to limestone bedrock ranges from 1½ to more than 3 feet. In most places the texture is silt loam throughout the profile, but in a few places the soil contains more sand or clay. The depth to the high-lime material is generally less than 30 inches, and in a few places it is as little as 7 inches. In some places the soil material is acid to depths of 18 to 24 inches.

Additional facts.—Kendaia soils are productive. They are fairly easy to work when not too wet. The surface layer is high in organic matter. When these soils are dry, water moves fairly well through the surface soil and subsoil, but it moves much more slowly through the dense substratum.

Kendaia silt loam, 0 to 3 percent slopes (KbA), is the soil described as typical for the Kendaia series. The surface layer is generally 6 to 9 inches thick. Small areas on the uninhabited islands in the eastern part of the county are acid to depths of 18 to 24 inches.

Capability.—Class III, subclass IIIw, and management group 7. Wetness is the major problem.

Suitable uses and management needs.—This soil is productive, but it needs to be drained by tile or ditches. It can be used for silage corn, small grains, hay, and improved pasture. If drained by complete systems of tile, it is suitable for corn and alfalfa, which do not do well in areas that are undrained or partially drained by open ditches. Filling in depressions improves surface drainage. Crops grow faster if topdressed early in spring with a fertilizer high in nitrate nitrogen.

Kendaia silt loam, 3 to 8 percent slopes (KbB), is like Kendaia silt loam, 0 to 3 percent slopes, except that a few places are somewhat eroded.

Capability.—Class III, subclass IIIw, and management group 7. Wetness is the major problem, but erosion is also a problem.

Suitable uses and management needs.—This soil is suited to the same crops as Kendaia silt loam, 0 to 3 percent slopes. It needs supplemental drainage. A few areas are drained by a complete system of tile. To prevent erosion, this soil should be worked across the slope in graded strips. On long slopes, diversion terraces are generally needed to intercept and carry off excess water. Ditches or tile may also be needed to intercept subsurface water. Surface drainage can be improved by grading to fill in depressions. Plants will grow faster if topdressed in spring with a fertilizer that is high in nitrate nitrogen.

Kendaia very stony silt loam, 0 to 3 percent slopes (KcA), is too stony to be tilled. The surface layer is about 6 inches thick. Some areas, mostly on the small uninhabited islands in the eastern part of the county, are acid to depths of 18 to 24 inches.

Capability.—Class VI, subclass VIs, and management group 14. Stoniness is the major problem.

Suitable uses and management needs.—This soil is used for woodland and pasture. The native pasture produces low-quality roughage consisting of Kentucky bluegrass, wild whiteclover, weeds, and water-tolerant plants. It would be very expensive to drain this soil and clear it of stones so that it could be used for crops. The best use for this soil is to let it revert to trees. If the surface stones are removed, this soil can be used and managed in the same way as Kendaia silt loam, 0 to 3 percent slopes.

Kendaia very stony silt loam, 3 to 8 percent slopes (KcB), has steeper slopes than Kendaia very stony silt loam, 0 to 3 percent slopes, but is otherwise the same. Included are a few very small areas that have slopes ranging from 8 to 15 percent.

Capability.—Class VI, subclass VIs, and management group 14. Stoniness is the major problem.

Suitable uses and management needs.—If the surface stones are removed, this soil can be used and managed in the same way as Kendaia silt loam, 3 to 8 percent slopes. Areas not cleared of stones should be used for woodland.

Livingston Series

The Livingston series consists of clay soils that are waterlogged or covered by water much of the time. These soils have formed from clays and silts that were deposited in inland seas. They occur in level or depressed areas throughout the county. Generally the areas are small. Most areas are next to or near the wet Covington and Kendaia soils. The trees of the forested areas are white-cedar and swamp hardwoods—elm, red maple, and yellow birch.

Typical profile (Livingston silty clay loam, 0 to 3 percent slopes):

0 to 11 inches—
Black mucky layer that has a weak granular structure. It is neutral (pH 6.6).

11 to 15 inches—
Dark-gray clayey layer that is slightly sticky when wet. The clay particles do not cling together to form any kind of structure, and the layer looks like one solid mass of soil material; this kind of layer is called structureless. The reaction is neutral (pH 7.2).

15 to 32 inches—
Gray clayey layer with many fine yellowish-brown mottles. It is slightly sticky when wet. The soil particles form weakly developed, slightly rounded blocks that range in diameter from ⅜ to ¾ inch. This layer is neutral (pH 7.2).

32 inches+—
Gray structureless clayey layer mottled with olive gray. The mottling is fainter and not as common as in the layer above. This layer is alkaline (pH somewhat higher than 7.2).

Variations.—The surface layer is from 1 inch to about 18 inches thick. In some places this layer is clayey and is about 6 inches thick. In places the underlying layers of clay are bluish gray and are not mottled.

Additional facts.—These soils occur in low areas, many at the level of the lake. Consequently, they lack outlets and are difficult to drain. The surface layer is high in organic matter.

Livingston silty clay loam, 0 to 3 percent slopes (LaA), is the soil described as typical of the series. Included with it are very small areas having gentle slopes ranging from 3 to 5 percent and some areas of Livingston silty muck.

Capability.—Class VI, subclass VIw, and management group 11. Extreme wetness is the major problem.

Suitable uses and management needs.—Unless this soil is drained, none of the crops grown locally are suitable except reed canarygrass. Swale grasses, rushes, sedges, cattails, alders, willows, and other water-tolerant plants grow in the open areas. Reed canarygrass grows well if seeded during a dry summer when the soil is dry enough to be worked. Pastures are not good unless drained. Reed canarygrass and any crops planted on drained areas will grow faster if a topdressing of fertilizer high in nitrate nitrogen is applied early in spring.

Lateral movement of water through the soil is very slow. The close spacing of tile lines necessary to drain the soil effectively makes this method of drainage uneconomical. Drainage by ditches may not be worthwhile.

Lyons Series

The Lyons series consists of very wet loamy soils that are waterlogged or covered by water much of the time. These soils have formed from high-lime materials that were left by glaciers. They occur throughout the county, mainly in small level areas or depressions. Most areas are next to or near the wet Kendaia and Covington soils and the slightly wet Amenia soils. Swamp trees, chiefly elm, red maple, yellow birch, poplar, and whitecedar, grow in the wooded areas.

Typical profile (Lyons silt loam, 0 to 3 percent slopes):

0 to 4 inches—
Black loamy layer that has a fairly good granular structure.

4 to 17 inches—
Very dark gray to dark gray loam stained with many grayish-brown, dark grayish-brown, and light olive-brown mottles. Soil particles cling together to form weakly developed, slightly rounded blocks that range in diameter from ⅛ to ¾ inch. This layer is neutral (pH 7.0).

17 to 25 inches—
Dark-gray loam with many olive-brown mottles. The layer is structureless, that is, it looks like one solid mass of soil material. It contains some flat stone fragments that are ⅛ inch long or longer. This layer is neutral (pH 7.2).

25 inches+—
Dark-gray sandy loam with few brown to dark-brown mottles. Soil particles cling together to form weakly developed plates that are ⅛ to ⅜ inch thick. Layer contains some flat stone fragments about ⅛ inch long. This layer is alkaline (pH higher than 7.5).

Variations.—In places the surface layer is black muck 1 to about 18 inches thick. The amount of mottling in the layers below varies greatly. The layers that are not mottled are commonly bluish gray.

Additional facts.—These soils are difficult to drain because they occur in low areas, most of which have no drainage outlets. The surface layer is high in organic matter.

Lyons silt loam, 0 to 3 percent slopes (LbA), is the soil described as typical of the Lyons series. In areas where the soil has been plowed the surface layer is 7 to 9 inches thick.

Capability.—Class VI, subclass VIw, and management group 11. Extreme wetness is the major problem.

Suitable uses and management needs.—Unless this soil is drained, none of the crops grown locally except reed canarygrass are suitable. The soil supports only trees or low-quality native pasture. Swale grasses, rushes, sedges, cattails, alders, willows, and other water-tolerant plants grow in the open areas. Reed canarygrass does well if seeded during a dry summer when the soil is dry enough to work. A few small areas have been drained by open ditches.

Reed canarygrass and any crops planted on drained areas grow faster if topdressed early in spring with a fertilizer high in nitrate nitrogen.

Lyons very stony silt loam, 0 to 3 percent slopes (LcA), is too stony to be tilled. Included with this soil are a few small areas that have slopes of 3 to 5 percent.

Capability.—Class VII, subclass VIIw, and management group 16. Extreme wetness and stoniness are the major problems.

Suitable uses and management needs.—This soil is suitable only for forests or wildlife. Open areas should be allowed to reforest naturally. In many areas the best way to use this soil is to develop habitats for muskrats or waterfowl.

Melrose Series

The Melrose series consists of brown, well-drained, sandy soils underlain by clay at depths of 1 to 4 feet. These soils have formed from sands deposited in lakes and seas. They are dominantly nearly level to gently sloping, but they range from level to steep. These soils occur in small areas throughout the county, except in the town of North Hero. They are of small extent in the county; the largest acreage is in the towns of Isle La Motte and South Hero. Most areas are near or next to the somewhat droughty Kars soils and the slightly wet Elmwood soils. The trees of the forested areas are mixed hardwoods, chiefly sugar maple, red maple, beech, gray birch, white pine, and hemlock.

Typical profile (Melrose fine sandy loam, 0 to 3 percent slopes):

0 to 9 inches—
Dark-brown sandy loam that has a fairly good granular structure.

9 to 14 inches—
Yellowish-brown friable sandy loam. Soil particles cling together to form weakly developed, slightly rounded blocks that range from ⅛ to ¾ inch in diameter. This layer is medium acid (pH 5.8).

14 to 17 inches—
Dark grayish-brown sandy loam that forms weakly developed, slightly rounded blocks. The blocks range from ⅛ to ¾ inch in diameter. They crush easily in the hand into individual sand grains. This layer is slightly acid (pH 6.2).

17 inches+—
Brown to dark-brown silty clay loam. The clayey particles cling together to form well-developed blocks that are slightly rounded or angular. The blocks range from ⅛ to ¾ inch in diameter. This layer is slightly acid (pH 6.2).

Variations.—Depth to the clay layer normally is 1½ to 2 feet but ranges from 1 to more than 4 feet. In some places the sandy layer directly above the clay layer is mottled with various colors. In unplowed areas the surface layer is 1 to 4 inches thick.

Additional facts.—These soils are easy to work. They dry out early in the spring. The natural fertility is fair to low. Water moves rapidly through the sandy layers and slowly through the clay layer. The slowing of water movement in the clay layer causes water to flow laterally on top of the clay during wet weather. These soils respond well to lime and fertilizer but are likely to require more than the loamy and clayey soils. They especially need potassium.

Melrose fine sandy loam, 0 to 3 percent slopes (MaA), is the soil described as typical of the Melrose series.

Capability.—Class I and management group 1. This soil is not subject to erosion. Management problems are minor.

Suitable uses and management needs.—This soil can be used for silage corn, small grains, hay, and improved pasture. It is suited to all of the crops grown locally, especially corn. Alfalfa can be grown if sufficient lime and fertilizer are applied.

Melrose fine sandy loam, 3 to 8 percent slopes (MaB), is the same as Melrose fine sandy loam, 0 to 3 percent slopes, except that the slopes are stronger.

Capability.—Class II, subclass IIe, and management group 2. Erosion is the major problem.

Suitable uses and management needs.—This soil is suited to the same crops as Melrose fine sandy loam, 0 to 3 percent slopes, but rotations should be longer. To prevent erosion, this soil should be worked across the slope in contour strips. On long slopes, diversion terraces may be needed to carry off excess surface water. If possible, the diversion terrace should be dug into the clay layer.

Melrose fine sandy loam, 8 to 15 percent slopes (MaC), is the same as Melrose fine sandy loam, 0 to 3 percent slopes, except for having steeper slopes.

Capability.—Class III, subclass IIIe, and management group 6. Erosion is the major problem.

Suitable uses and management needs.—This soil is suited to the same crops as Melrose fine sandy loam, 0 to 3 percent slopes, but rotations should be longer. It is more difficult to control erosion and to operate farm machinery on this soil than on the Melrose soils that have milder slopes. To prevent erosion, this soil should be worked across the slope in contour strips. On long slopes, diversion terraces may be needed to carry off excess surface water. Where possible, the bottom of the diversion terrace should be in the clay layer.

Melrose fine sandy loam, 15 to 25 percent slopes (MaD), is similar to Melrose fine sandy loam, 0 to 3 percent slopes, but it has much steeper slopes. Included with this soil is a small area that has slopes of 25 to 35 percent.

Capability.—Class IV, subclass IVe, and management group 9. Erosion is the major problem.

Suitable uses and management needs.—This soil is suited to the same crops as Melrose fine sandy loam, 0 to 3 percent slopes, but rotations should be longer. Because of steep slopes, however, it is best to use this soil for tall grasses and legumes. This soil is excellent for early spring pasture. It should be plowed only when the pastures need to be reseeded and should be worked across the slope in contour strips to prevent erosion.

Nellis Series

The Nellis series consists of brown, well-drained, loamy soils. They have formed from high-lime materials that were left by glaciers. They are mostly gently sloping, but they range from nearly level to steep. In most years these soils are neither very dry nor very wet. The Nellis soils occur throughout the county, most extensively in the northwestern part of Isle La Motte. Most areas are near or adjacent to the droughty, shallow Benson soils, the slightly wet Amenia soils, and the wet Kendaia soils.

The trees of the forested areas are mixed hardwoods, mainly sugar maple, beech, yellow birch, white ash, and basswood. Some red oak, white oak, red maple, hophornbeam, white pine, whitecedar, and hemlock trees are also in the stands. Among the native grasses are Kentucky bluegrass and povertygrass. Whiteclover grows wild.

Typical profile (Nellis silt loam, 3 to 8 percent slopes):

0 to 8 inches—
Brown to dark-brown silt loam that has a good granular structure.

8 to 18 inches—
Brown silt loam that contains some shaly fragments. Soil particles cling together to form weakly developed, slightly rounded blocks that are from ⅛ to ½ inch in diameter. This layer is neutral (pH 6.6).

18 inches+—
Very dark brown silt loam that contains few shaly fragments. Soil particles cling together to form weakly developed plates that range in thickness from 1/16 to ¼ inch. The layer is generally alkaline (pH higher than 7.5).

Variations.—In some places these soils are 2 to 3 feet deep over limestone bedrock or sandy and gravelly material. In many areas the depth to the very dark brown alkaline layer is 2 feet. The amount of shale and limestone fragments is highly variable.

Additional facts.—These soils dry out early in spring. In most years, the moisture conditions are favorable for plant growth. Water moves through the uppermost 18 to 24 inches at a moderate rate. Below a depth of 24 inches it moves somewhat more slowly, but not so slowly that the soil remains wet.

Nellis silt loam, 0 to 3 percent slopes (NaA), is like the soil described as typical of the series, except for being nearly level.

Capability.—Class I and management group 1. This soil is not subject to erosion and has only minor problems.

Suitable uses and management needs.—This soil can be used for silage corn, small grains, hay, and improved pasture. It is especially well suited to alfalfa and corn. It is highly productive under good management.

This soil is suited to trees of the Northern hardwood and Oak-hickory forest types. Sugar maple, red oak, white ash, and other desirable species grow well and yield large amounts of good timber.

Nellis silt loam, 3 to 8 percent slopes (NaB), is the soil described as typical for the Nellis series. It is slightly eroded in some areas.

Capability.—Class II, subclass IIe, and management group 2. Erosion is the major problem.

Suitable uses and management needs.—This soil is suited to the same crops as Nellis silt loam, 0 to 3 percent slopes, but rotations should be longer. If precautions are not taken when this soil is tilled, it will erode. Where possible it should be worked across the slope in contour strips, to prevent erosion. On long slopes, diversion terraces may be needed to carry off surface water.

Nellis silt loam, 8 to 15 percent slopes (NaC), is moderately eroded in some areas. Included with this soil are some complex slopes of 3 to 8 percent.

Capability.—Class III, subclass IIIe, and management group 5. Erosion is the major problem.

Suitable uses and management needs.—This soil is suited to the same crops as Nellis silt loam, 0 to 3 percent slopes, but rotations should be longer. Where possible this soil should be worked across the slope in contour strips. On long slopes, diversion terraces may be needed to carry off surface water. It is more difficult to control

erosion and to operate modern farm machinery on this soil than on the Nellis silt loams that have milder slopes.

Nellis silt loam, 15 to 25 percent slopes (NaD), is moderately eroded in many areas. Included with this soil are many complex slopes of 8 to 15 percent.

Capability.—Class IV, subclass IVe, and management group 9. Erosion is the major problem.

Suitable uses and management needs.—This soil is suited to the same crops as Nellis silt loam, 0 to 3 percent slopes, but the rotations should be longer. Although the soil could be used for row crops, it is better, because of the steep slopes, to grow tall grasses and legumes to be used for rotation hay and pasture. This soil is excellent for early spring pasture.

This soil should be plowed only when the pastures or hayfields need to be reseeded. To prevent erosion, it should be worked across the slope in contour strips. The steep and complex slopes make it very difficult to control erosion and to use modern farm machinery.

Nellis very stony silt loam, 0 to 3 percent slopes (NbA), is too stony to be tilled and its surface layer is only 5 or 6 inches thick.

Capability.—Class VI, subclass VIs, and management group 12. Stoniness is the major problem.

Suitable uses and management needs.—This soil is suitable only for native pasture and trees. Sugar maple, red oak, white ash, and other desirable species grow well and yield large amounts of good timber. If more cropland or improved pasture is needed, this soil can be cleared of surface stones. It can then be used and managed in the same way as Nellis silt loam, 0 to 3 percent slopes.

Nellis very stony silt loam, 3 to 8 percent slopes (NbB), is like Nellis very stony silt loam, 0 to 3 percent slopes, except that it has stronger slopes.

Capability.—Class VI, subclass VIs, and management group 12. Stoniness is the major problem.

Suitable uses and management needs.—This soil is suitable for native pasture and trees. If more cropland or improved pasture is needed, surface stones can be removed. This soil can then be used and managed in the same way as Nellis silt loam, 3 to 8 percent slopes.

Nellis very stony silt loam, 8 to 15 percent slopes (NbC), is like Nellis very stony silt loam, 0 to 3 percent slopes, except that the slopes are much steeper.

Capability.—Class VI, subclass VIs, and management group 12. Stoniness is the major problem.

Suitable uses and management needs.—This soil is suitable for native pasture and trees. If more cropland or improved pasture is needed, the surface stones can be removed and then this soil can be used and managed in the same way as Nellis silt loam, 8 to 15 percent slopes.

Nellis very stony silt loam, 15 to 25 percent slopes (NbD), is similar to Nellis very stony silt loam, 0 to 3 percent slopes, except that the slopes are much steeper. Included with this soil are a few small areas that have slopes of 25 to 35 percent.

Capability.—Class VI, subclass VIs, and management group 12. Stoniness is the major problem.

Suitable uses and management needs.—This soil is suitable only for native pasture and trees. If less strongly sloping soils are available for pasture, it is practical to use this soil for growing trees. Some areas could be cleared of stones if improved pasture is needed. If surface stones are removed so that this soil can be tilled, it can be used and managed in the same way as Nellis silt loam, 15 to 25 percent slopes.

St. Albans Series

The St. Albans series consists of loamy brown soils underlain by bedrock of slate or shale interbedded in places with thin layers of limestone. These soils have formed from shale and slaty material left by the glacier, and in some places, from fragments of the underlying rock. Gentle slopes predominate, but the slope range is from gentle to steep.

In this county, the St. Albans soils are mapped only in the St. Albans-Dutchess complex, which occurs on small uninhabited islands in the eastern part of the county. The two soils are so intermixed that it is not possible to map each one separately. Generally, these soils are adjacent to or near the slightly wet Amenia soils, the wet Covington and Kendaia soils, and the very wet Livingston soils. The trees of the forested areas are mixed hardwoods, mainly sugar maple, beech, yellow birch, and red maple. Some white pine, hemlock, and redcedar trees are also in the stands.

Typical profile (St. Albans loam, 3 to 8 percent slopes):

0 to 8 inches—
Very dark brown loam that has granular structure.

8 to 12 inches—
Light olive-brown loam that contains, in places, some slate or shale fragments ⅛ to ½ inch in length. Soil particles cling together to form weakly developed, slightly rounded blocks that range in diameter from ⅛ to ¾ inch. This layer is usually strongly acid (pH about 5.2).

12 to 24 inches—
Olive to grayish-brown loam that contains, in places, many slate or shale fragments ⅛ to ½ inch in length. Soil particles cling together to form weakly developed, slightly rounded blocks that range in diameter from ¼ to ¾ inch. In places in the lower part of this layer, the soil particles form weakly developed plates 1/16 to ¼ inch thick. This layer is slightly acid (pH about 6.3).

24 inches+—
Grayish-brown loam. Where this layer is not hard, the soil particles cling together to form weakly developed, rounded blocks that vary in diameter from ¼ to ¾ inch; where it is so hard that digging through it with a spade is difficult, the soil particles form plates 1/16 to ¼ inch thick. In places slate or shale fragments are few, but generally there are many that range in length from ⅛ inch to 6 inches. This layer is slightly acid to neutral (pH about 6.4).

Variations.—The depth to bedrock generally ranges from ½ foot to about 2½ feet, but outcrops of bedrock are common. In some areas the layers below the surface soil are somewhat thinner than those described as typical, and in areas where the soil is shallow, some layers are missing.

Additional facts.—Water moves through the St. Albans soil at a moderate rate. Where the soil is shallow, it is somewhat droughty. It dries out early in spring.

Remarks.—The Dutchess soils have about the same color, texture, and structure as the typical St. Albans soil. The principal difference between the two soils is that the Dutchess soils are normally strongly acid throughout, but the St. Albans is less acid with depth.

St. Albans-Dutchess loams, 3 to 8 percent slopes (SaB), is a complex of deep soils that have no outcrops of rock. The St. Albans soil in this mapping unit is the soil described as typical of the St. Albans series. The Dutchess soil is similar but is normally strongly acid throughout.

Capability.—Class II, subclass IIe, and management group 2. Erosion is the major problem.

Suitable uses and management needs.—These soils can be used for silage corn, small grains, hay, and improved pasture. Alfalfa can be grown if enough lime and fertilizer are used. If these soils are tilled, they should be worked across the slope in contour strips. On long slopes, diversion terraces may be needed to intercept and carry off surplus surface water.

St. Albans-Dutchess rocky loams, 3 to 8 percent slopes (SbB), is the most extensive mapping unit of the St. Albans-Dutchess complex. Rock outcrops are 50 to 200 feet apart.

Capability.—Class II, subclass IIs, and management group 4. Rockiness and shallowness are the major problems. If these soils are cultivated, erosion is also a problem.

Suitable uses and management needs.—These soils are suited to the same crops as St. Albans-Dutchess loams, 3 to 8 percent slopes. The shallow areas may be too droughty for Ladino clover. If these soils are tilled they should be worked across the slope in contour or field strips. Rock outcrops interfere with tillage.

St. Albans-Dutchess rocky loams, 8 to 15 percent slopes (SbC), have slopes that are generally uniform, but the mapping unit includes some broken slopes. Also included with this complex are some uniform slopes of 15 to 25 percent and a very small area where there are uniform slopes of 25 to 35 percent.

Capability.—Class III, subclass IIIs, and management group 8. Rockiness and shallowness are the major problems. If these soils are cultivated, erosion is also a problem.

Suitable uses and management needs.—These soils are suited to the same crops as St. Albans-Dutchess rocky loams, 3 to 8 percent slopes. To prevent erosion, they should be worked across the slope in contour or field strips. Rock outcrops interfere with tillage.

St. Albans-Dutchess very rocky loams, 3 to 8 percent slopes (ScB), are shallower than St. Albans-Dutchess rocky loams, 3 to 8 percent slopes. The rock outcrops are so near together that tillage with modern farm machinery is impossible.

Capability.—Class VI, subclass VIs, and management group 13. Extreme rockiness and shallowness are the major problems.

Suitable uses and management needs.—These soils are suitable only for native pasture or trees. The pasture produces low-quality roughage consisting of Kentucky bluegrass, povertygrass, and various weeds. Probably it is best to plant these soils to trees or to allow natural reforestation.

St. Albans-Dutchess very rocky loams, 15 to 25 percent slopes (ScD), is like St. Albans-Dutchess very rocky loams, 3 to 8 percent slopes, except for having steeper slopes. Included with this mapping unit is a very small area of soils that have slopes of 25 to 35 percent.

Capability.—Class VI, subclass VIs, and management group 13. Extreme rockiness and shallowness are the major problems.

Suitable uses and management needs.—This mapping unit is suitable for the same uses and needs the same kind of management as St. Albans-Dutchess very rocky loams, 3 to 8 percent slopes.

Swanton Series

The Swanton series consists of wet, dark-colored, sandy soils that are underlain by clay at depths of 1 to 4 feet, most commonly at 2 feet. These soils have formed from sands that were deposited in glacial lakes and inland seas. In most years they are wet for a long time in spring and fall. Consequently, the subsoil is mottled with bright colors. The soils are dominantly level or nearly so, but some are gently sloping. They occur on broad flats throughout the county; the largest areas are in the town of Alburg.

Generally, Swanton soils lie next to or near the well-drained Melrose soils, the slightly wet Elmwood soils, the wet Covington soils, and the very wet Whately soils. The trees of the forested areas are elm, red maple, black ash, white ash, yellow birch, gray birch, white pine, whitecedar, and hemlock.

Typical profile (Swanton fine sandy loam, 0 to 3 percent slopes):

0 to 9 inches—
Black sandy loam that has fairly well developed granular structure.

9 to 11 inches—
Grayish-brown friable sand mottled with yellowish brown and olive brown. The sandy particles do not cling together to form any kind of structure; they crumble very easily in the hand. This layer is neutral (pH 6.6).

11 to 35 inches—
Dark grayish-brown to olive-brown sandy loam that gets sandier with depth. It has many large reddish and yellowish-brown mottles. In the upper part of this layer, the sand particles cling together to form weakly developed, slightly rounded blocks; in the lower part, they generally do not form any kind of structure but crumble easily in the hand into individual sand grains. This layer is neutral (pH 7.0).

35 to 42 inches—
Dark-gray fine and medium sand. It has a few medium, distinct mottles of olive brown. This layer is massive but crushes easily to single grains or very weak fine crumbs. The reaction is neutral (pH 7.0).

42 inches+—
Gray clay layer that is sticky when wet and has some olive-brown mottles. The clay particles cling together to form fairly well developed blocks that are less than ½ inch in diameter. Some of the blocks are slightly rounded, and others have sharp, angled corners. This layer is neutral in reaction (pH 7.0).

Variations.—In some areas the surface layer has a loam texture. Although in most places the subsoil is sandy loam, in some places it contains enough clay to give it a clayey feel.

Additional facts.—These wet soils are hard to work early in spring. They are easy to work when not too wet. If the weather is rainy in fall, it is difficult to harvest corn. Unless these soils are drained they are not suitable for corn and alfalfa. Crops respond well to lime and fertilizer. Generally, these soils contain a large amount of organic matter. They are easy to drain by tile and open ditches.

Swanton fine sandy loam, 0 to 3 percent slopes (SdA), is the soil described as typical for the Swanton series. It is not eroded.

Capability.—Class III, subclass IIIw, and management group 7. Wetness is the major problem.

Suitable uses and management needs.—This soil can be used for crops and pasture, but unless it is drained it is not as productive as it could be. Silage corn, small grains, hay, and pasture plants are suitable crops. Corn and alfalfa can be grown in drained areas. Alfalfa needs

lime and fertilizer. Crops grow faster if topdressed early in spring with a fertilizer high in nitrate nitrogen.

Swanton fine sandy loam, 3 to 8 percent slopes (SdB), has lost some of its surface soil through erosion. The slopes are mostly 3 to 5 percent.

Capability.—Class III, subclass IIIw, management group 7. Wetness is the major problem. Erosion is also a problem.

Suitable uses and management needs.—This soil is suited to the same crops as Swanton fine sandy loam, 0 to 3 percent slopes. It needs supplemental drainage. It is necessary to cut at least 4 inches into the clay layer to make interception drains or tile effective. To prevent erosion, this soil should be worked across the slope in graded strips.

Vergennes Series

The Vergennes series consists of brown, slightly wet, heavy clay soils that, in most years, remain wet late in spring and become wet early in fall. These soils have formed from neutral silts and clays of marine origin. They are nearly level to gently sloping, except for a few small areas that are sloping. They occur in small scattered areas in all towns of the county except Isle La Motte. The largest area is in the town of South Hero near South Hero village. Most areas are near or next to the wet Covington and Kendaia soils. Practically none are forested.

Typical profile (Vergennes silty clay loam, 3 to 8 percent slopes):

0 to 7 inches—
Dark grayish-brown silty clay loam that has a good granular structure.

7 to 15 inches—
Brown to dark-brown very firm clay loam. Clay particles cling together to form well-developed angular blocks that range in diameter from ⅛ to ¾ inch. This layer is usually slightly acid (pH 6.5).

15 to 25 inches—
Brown to grayish-brown firm silty clay loam mottled with yellowish brown. Clay particles cling together to form well-developed angular blocks that range in diameter from ⅛ to ¾ inch. This layer is usually slightly acid (pH 6.5).

25 inches+—
Dark grayish-brown silty clay loam. This layer is usually neutral (pH 7.0).

Variations.—Although these soils are generally deep, in places they overlie limestone bedrock at depths of 2 to 3 feet. In these areas the layer directly above the bedrock is generally less clayey than is typical.

Additional facts.—These heavy clay soils are hard to work most of the time. Water moves through them slowly. They are so wet and sticky in spring that it is impossible to seed them early in spring, and it is difficult to harvest corn in the fall if there has been much rain. Most of the acreage is suitable for hay and pasture without artificial drainage. These soils are productive under good management. They do not need as much potassium as the sandy and gravelly soils.

Vergennes silty clay loam, 0 to 3 percent slopes (VaA), is similar to the soil described as typical for the Vergennes series, but in some areas it is mottled somewhat nearer the surface.

Capability.—Class II, subclass IIw, and management group 3. Wetness is the major problem.

Suitable uses and management needs.—This soil can be used for silage corn, small grains, hay, and improved pasture. It is especially well suited to birdsfoot trefoil. Corn for silage and alfalfa for hay can be grown, but in some places the soil is too wet to produce good stands. Tile drainage of bothersome wet spots and land grading to remove depressions where surface water accumulates make this soil more suitable for corn and alfalfa.

Vergennes silty clay loam, 3 to 8 percent slopes (VaB), is the soil described as typical for the Vergennes series. It is slightly eroded in some areas. Included in this mapping unit is a very small area that has slopes of 8 to 15 percent.

Capability.—Class II, subclass IIw, and management group 3. Wetness and erosion are the major problems.

Suitable uses and management needs.—The crops suited to Vergennes silty clay loam, 0 to 3 percent slopes, are suited to this soil. To prevent erosion, this soil should be worked across the slope in graded strips. On long slopes, diversion terraces may be needed to carry off surface water.

Whately Series

The Whately series consists of very wet sandy soils that are underlain by clay at depths of 1 to 4 feet. These soils have formed from sands that were deposited in lakes and seas. They are waterlogged or covered by water much of the time. These soils occur throughout the county, generally in small level or depressed areas. Some areas are gently sloping.

Most areas of Whately soils are near or next to the well-drained Melrose soils, the slightly wet Elmwood soils, and the wet Swanton soils. The trees of the forested areas are chiefly red maple, elm, yellow birch, poplar, and white-cedar.

Typical profile (Whately loam, 0 to 3 percent slopes):

0 to 7 inches—
Black loam that has a weak granular structure. This layer is mucky in many places.

7 to 15 inches—
Gray sand particles that do not cling together to form any kind of structure. This layer is neutral (pH value of 6.6).

15 inches+—
Gray clay with many large reddish and brown mottles. It is slightly sticky. Clay particles do not cling together to form any kind of structure.

Variations.—The depth to the clay layer ranges from 1 to more than 4 feet but is normally about 2 feet. The surface layer is generally loamy or mucky but in places it is a sandy loam. The loam and sandy loam are 5 to 8 inches thick. The muck is 1 to 18 inches thick. In places the sandy layer is grayish brown with bright-brown mottles; in other places it is bluish gray and unmottled.

Additional facts.—Whately soils contain a large amount of organic matter. When these soils are not saturated, water moves rapidly through the mucky and sandy layers and slowly through the clay layer. Consequently, these soils are easy to drain by tile or open ditches if suitable outlets are available. Many areas, however, are so low that outlets are not available.

Whately loam, 0 to 3 percent slopes (WaA), is the only soil of this series mapped in the county. Mapped with it are small areas that have 3 to 5 percent slopes.

Capability.—Class VI, subclass VIw, and management group 11. Extreme wetness is the major problem.

Suitable uses and management needs.—In its natural condition this soil is suitable only for trees or low-grade pasture. Cleared areas have grown up to swale grass, sedges, rushes, cattails, alders, willows, and other water-tolerant plants. Reed canarygrass grows well if it is seeded during a dry summer when the soil is dry enough to be worked.

This soil will not produce hay or good pasture stands unless it is drained. Drained areas can be used for crops. Plants will grow faster if a topdressing of fertilizer high in nitrate nitrogen is applied early in spring. Drainage may be too expensive to be practical.

Formation and Classification of Soils

In table 4, the soil series in Grand Isle County are shown by order and great soil group, and some of the factors in the formation of each series are described.

Factors of Soil Formation

The nature of a soil depends upon the combination of five major factors—climate, living organisms, parent materials, topography, and time. All five of these factors come into play in the formation of every soil. The relative importance of each differs from place to place. It is possible, but not common, for one factor to dominate in

TABLE 4.—*Classification of the soil series by higher categories and some of the factors that have contributed to differences in soil morphology*

ZONAL

Great soil group and series	Natural drainage	Topography	Parent material
Brown Podzolic soils:			
Melrose	Good	Dominantly nearly level to gently sloping.	Marine or lacustrine sands mainly of schistose and granitic origin.
Elmwood	Moderately good	Level to gently sloping	Marine or lacustrine sands mainly of schistose and granitic origin.
St. Albans	Good to excessive	Gently sloping to steep	Glacial till or residuum derived mainly from black or gray slate and shale and some limestone.
Dutchess	Good to excessive	Gently sloping to steep	Slaty or shaly glacial till.
Gray-Brown Podzolic soils:			
Kars	Good to excessive	Nearly level to steep	Marine or lacustrine calcareous sands and gravels derived mainly from limestone, slate, and shale.
Vergennes [1]	Moderately good	Nearly level to gently sloping	Neutral silts and clays of marine origin.

INTRAZONAL

Great soil group and series	Natural drainage	Topography	Parent material
Brown Forest soils:			
Benson	Somewhat excessive to excessive.	Gently undulating to steep	Highly calcareous glacial till or residuum derived mainly from limestone and calcareous shales.
Nellis	Good	Nearly level to steep	Highly calcareous glacial till derived mainly from limestone and calcareous shale.
Amenia	Moderately good	Nearly level to moderately sloping	Highly calcareous glacial till derived mainly from limestone and calcareous shale.
Low-Humic Gley soils:			
Covington	Somewhat poor to poor.	Level to gently sloping	Neutral silts and clays of marine origin.
Kendaia	Somewhat poor to poor.	Level to gently sloping	Highly calcareous glacial till derived mainly from limestone and calcareous shale.
Swanton	Somewhat poor to poor.	Level to gently sloping	Marine or lacustrine sands mainly of schistose and granitic origin.
Humic Gley soils:			
Lyons	Very poor	Level or depressed	Highly calcareous glacial till derived mainly from limestone and calcareous shale.
Half-Bog soils:			
Livingston	Very poor	Level or depressed	Neutral silts and clays of marine origin.
Whately	Very poor	Level, depressed, or gently sloping	Marine and lacustrine sands mainly of schistose or granitic origin.
Bog soils:			
Carlisle muck	Very poor	Level or depressed	Organic material derived mainly from forest vegetation.
Balch peat	Very poor	Level or depressed	Organic material derived mainly from forest vegetation.
Fresh water marsh [2]	Very poor	Level	Various mineral and organic materials.

[1] The Vergennes soils are intergrades between the Gray-Brown Podzolic and the Brown Forest great soil group.
[2] Because of flooding these soils may have some characteristics of Alluvial soils.

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the formation of a soil and to fix most of its properties. Generally, it is the interaction of the five factors that determine the character of each soil.

Climate.—Grand Isle County has a cool-temperate, humid climate, which is uniform throughout the county. The seasons are strongly contrasted, although the climate is tempered somewhat by the surrounding waters of Lake Champlain.

The winters are moderately cold. About 20 days of subzero weather a winter is normal. The ground remains frozen for many months; consequently, little leaching takes place. The organic matter that accumulates on the surface does not decay rapidly, because the summers are neither very long nor intensely hot. Normally, rainfall is plentiful and well distributed throughout the year. Winds of damaging force are rare.

There is no United States Weather Bureau station in Grand Isle County, but the climate is approximately the same as at Burlington in Chittenden County. Table 5 shows monthly, seasonal, and annual temperatures and precipitation at the Burlington station. The frost-free season at Burlington averages 162 days. The average date of the last frost in spring is April 29; the latest recorded was on May 21. The average date of the first frost in fall is October 8; the earliest recorded was on September 15.

TABLE 5.—*Temperature and precipitation at Burlington Station,*[1] *Chittenden County, Vermont*

[Elevation, 331 feet]

Month	Temperature [2]			Precipitation [3]			
	Average	Absolute maximum	Absolute minimum	Average	Driest year (1881)	Wettest year (1897)	Average snowfall
	° F.	° F.	° F.	Inches	Inches	Inches	Inches
December	22. 8	63	−25	1. 88	1. 89	2. 10	12. 6
January	17. 9	64	−27	1. 89	. 88	2. 50	14. 6
February	18. 1	56	−28	1. 53	1. 79	1. 08	14. 4
Winter	19. 6	64	−28	5. 30	4. 56	5. 68	41. 6
March	29. 3	71	−20	2. 19	1. 56	2. 49	13. 7
April	42. 3	85	5	2. 63	. 62	4. 01	3. 9
May	55. 4	92	26	2. 89	2. 27	5. 00	. 1
Spring	42. 3	92	−20	7. 71	4. 45	11. 50	17. 7
June	65. 5	94	33	3. 57	1. 89	5. 63	0
July	70. 4	100	43	3. 75	2. 22	8. 48	0
August	68. 1	98	38	3. 01	2. 69	4. 08	0
Summer	68. 0	100	33	10. 33	6. 80	18. 19	0
September	59. 9	92	25	3. 14	2. 34	2. 13	0
October	48. 2	83	17	2. 89	1. 54	1. 53	. 4
November	36. 4	70	−10	2. 85	1. 30	4. 41	7. 2
Fall	48. 1	92	−10	8. 88	5. 18	8. 07	7. 6
Year	44. 5	100	−28	32. 22	20. 99	43. 44	66. 9

[1] There is no United States Weather Bureau station in Grand Isle County, but the climate is approximately the same as at Burlington. Grand Isle has about the same temperature but less rain and snow.

[2] Average temperature based on a 67-year record, through 1955; highest and lowest temperatures based on a 47-year record, through 1930.

[3] Average precipitation based on a 114-year record, through 1955; wettest and driest years based on a 113-year record, in the period 1828–1955; snowfall based on a 47-year record, through 1930.

Living organisms.—Vegetation was an important factor in the formation of practically all the soils of the county, but since it was uniform over most of the county it does not account for significant differences among the soils. All of the soils developed under dense forests of hardwoods, softwoods, and water-tolerant trees.

Sedges, rushes, and ferns grow in the wet areas. They may account for the dark colors and high organic-matter content of the wet soils.

Parent materials.—The soils of Grand Isle County have developed chiefly from glacial till and marine silts and clays and, to a lesser extent, from sands, gravels, and organic deposits. Practically all of these materials were calcareous or neutral. They were deposited over the Ordovician bedrock in a mixed pattern, which accounts for the complex pattern of soils in the county. The parent material of each soil series in the county is described in table 4.

Topography.—Grand Isle County lies in the Champlain Valley physiographic region. The topography is dominantly flat to gently undulating.

Topography affects drainage. Drainage, in turn, affects the formation of soils. Many of the soils have poor external and internal drainage because they are level and near the level of Lake Champlain.

Time.—The parent materials of the soils of the county are younger than those of the soils in the highlands to the east and west. While the rocks in the highlands have been in place and exposed to soil-forming processes for 10,000 to 12,000 years,[1] the valley was inundated by fresh water, then by sea water, and then by fresh water again. Nevertheless, the zonal soils of the county are just as well developed as the soils of the highlands.

Classification of Soils by Higher Categories

The highest category of soil classification is the order—zonal, intrazonal, or azonal. Zonal soils have genetic horizons that reflect the predominant influence of climate and living organisms, chiefly vegetation. Intrazonal soils have genetic horizons that reflect the dominant influence of topography, parent materials, or time. No soils of the azonal order have been mapped in this county.

The next category generally used is the great soil group. Seven great soil groups are represented in Grand Isle County. The zonal order is represented by soils of the Brown Podzolic and Gray-Brown Podzolic great soil groups; and the intrazonal order by soils of the Brown Forest, Low-Humic Gley, Humic Gley, Half-Bog, and Bog great soil groups.

Table 4 shows the classification of the soils of Grand Isle County by order and great soil group.

Zonal soils

The zonal order is represented in this county by two great soil groups, the Brown Podzolic and the Gray-Brown Podzolic soils. Although the county is in the region where podzolic soils are common, only about 6

[1] SAUER, C. O. THE END OF THE ICE AGE AND ITS WITNESSES. Geog. Rev. 47: 29–43. 1957.

percent of its area consists of such soils. The action of soil fauna has prevented the accumulation of an organic mat and the consequent formation of humic acids, without which podzolization cannot take place. A high percentage of carbonate in the parent material has retarded accumulation of sesquioxides or silicate clays. Brown Podzolic and Gray-Brown Podzolic soils occur in abundance, however, within short distances to the east and west.

BROWN PODZOLIC SOILS

The Brown Podzolic soils in the county are the Melrose, Elmwood, St. Albans, and Dutchess. They are mature soils that have distinct, genetically related horizons in an A_1–B_2–C sequence. These soils, under forest, have a 1- to 2-inch organic mat on the surface. The upper part of the mat consists of undecomposed tree leaves, needles, cones, or branches, and the lower part, of partially decomposed remnants of the same materials.

The A_1 horizon is usually very dark brown, friable, and 1 to 4 inches thick. Beneath the A_1 is the friable B horizon, which is brown to dark brown, yellowish brown, or olive brown. Most of the B horizon has a weak fine crumb or granular structure, but in places it is weak or very weak subangular blocky. The color is brightest in the upper part of the horizon and pales gradually with depth. In some areas the soils are more highly podzolized and the A_1 horizon is replaced with a light-gray leached layer about 1 inch thick, which is called an A_2 horizon, or bleicherde. In these places the upper part of the B horizon may be a stronger brown than the normal B horizon. Such soils are very weakly developed Podzols.

Podzolization takes place in the following manner. Much of the moisture from precipitation percolates through the organic mat. Humic acids leached out of this organic layer combine chemically with aluminum and iron leached from the mineral particles in the A horizon to form complex sesquioxide-humate compounds. These complex compounds are moved only short distances before they precipitate or gel in the B horizon. Some of the iron and aluminum is carried further downward and is removed in the ground water. The sesquioxide-organic compounds are of strong reddish or yellowish colors. They coat the mineral particles in the B horizon when the compounds are precipitated or gelled. The upper part of the B horizon has the strongest color because that is where most of the complex compounds accumulate through chemical or microbial activity. Apparently only a small amount of iron and aluminum is needed to give a strong color to the B horizon, because the mineral particles in the A_1 horizon are only slightly weathered. The leaching by humic acids results in concentration of silica in the A horizon and of iron and aluminum oxides in the B horizon.

The A horizon is dark-colored throughout because of the staining of the mineral particles by humates produced by the activity of fauna. Small earthworms, millipeds, ants, spiders, and other fauna mix into the A_1 horizon material from the upper part of the B horizon and some of the organic matter from the organic mat. There is no accumulation of clay in the B horizon.

The Elmwood soils are representative of the Brown Podzolic group. The following profile was observed on a 2-percent slope, on Isle La Motte, about ½ mile east of Sandy Point.

Elmwood very fine sandy loam, forested (all colors moist):

A_{00} 1½ to ¾ inches, litter of pine and hemlock needles and hemlock cones.

A_{01} ¾ to 0 inch, partially decomposed needles and twigs.

A_1 0 to 4 inches, very dark brown (10YR 2/2) very fine sandy loam; moderate fine and medium granular structure; very friable; many tree roots; pH 5.5; clear, smooth boundary.

B_{21} 4 to 8 inches, brown to dark-brown (7.5YR 4/4) very fine sandy loam; weak medium subangular blocky structure that crushes to weak fine granular peds; very friable; many tree roots; pH 5.4; abrupt, smooth boundary.

B_{22} 8 to 10 inches, dark yellowish-brown (10YR 4/4) very fine sandy loam; very weak fine subangular blocky structure; very friable, tree roots common; pH 5.4; abrupt, wavy boundary.

B_{3g} 10 to 15 inches, yellowish-brown (10YR 5/4) loamy very fine sand; a few, medium, distinct mottles of dark reddish brown (2.5YR 3/4) and dark red (2.5 YR 3/6); weak medium subangular blocky structure; very friable; tree roots common; pH 5.2; clear, wavy boundary.

C_{1g} 15 to 24 inches, grayish-brown (2.5Y 5/2) loamy fine sand; many, coarse, prominent mottles of dark reddish brown (2.5YR 2/4) and dark yellowish brown (10YR 4/4); weak to moderate fine subangular blocky structure; very friable; few tree roots; pH 5.6; clear, smooth boundary.

C_{2g} 24 to 31 inches, dark grayish-brown (2.5Y 4/2) loamy fine sand; many, coarse, prominent, dark reddish-brown (5YR 3/2) mottles; very weak fine subangular blocky structure; very friable; few tree roots; pH 5.6; abrupt, wavy boundary.

D_uG 31 inches +, gray (5Y 5/1) silty clay; many, medium, prominent, brown to dark-brown (7.5YR 4/4) mottles; weak thick platy structure that breaks to moderate fine and medium subangular blocks; few tree roots; pH 6.0.

GRAY-BROWN PODZOLIC SOILS

The Kars and Vergennes soils are the Gray-Brown Podzolic soils of Grand Isle County. Their total acreage is 2 percent of the area of the county. These soils have formed by the podzolization process and have certain features in common with Brown Podzolic soils.

Normally, Gray-Brown Podzolic soils have an A_1–A_2–B_{2t}–C horizon sequence. An organic mat of leaf litter overlies the mineral soil. These soils have a crumb or granular A_1 horizon that is 1 to 3 inches thick; an A_2 horizon that is 5 to 12 inches thick, has weak platy or subangular blocky structure, and is paler in color than the horizon above or below; and a B_{2t} horizon that is 12 to 20 inches thick and has moderate subangular blocky structure with distinct clay skins on all ped surfaces. The B horizon contains more clay than the A or C horizons. The base saturation is greater than 35 percent.

The Kars and Vergennes soils have developed on neutral to calcareous parent materials and are not so leached of bases as the associated Brown Podzolic soils. The horizons are more distinct in the sandy Kars soils than in the clayey Vergennes soils. In most areas the A_2 horizon has been destroyed by plowing, but it is still evident in places under the plow layer of the Kars soils. Clay flows in the B horizon are generally not very distinct, but there is more clay in the B horizon than in the A horizon, particularly in the soils of the Kars series. Both the Vergennes and Kars soils in this county may be intergrades between the Brown Forest and the Gray-Brown Podzolic great soil groups.

The following profile was observed in a gravel pit in the town of Isle La Motte, ½ mile west of Isle La Motte village.

Kars fine sandy loam, pastured (all colors moist):

A_p 0 to 8 inches, brown to dark-brown (10YR 4/3) fine sandy loam; weak fine granular structure; very friable; 5 percent coarse skeleton of ½-inch to 1-inch pebbles; pH 6.4.

A_2 8 to 12 inches, yellowish-brown (10YR 5/6) coarse sandy loam; very weak coarse subangular blocky structure that crushes to weak fine granular peds; very friable; 10 percent coarse skeleton of quartz pebbles, ½ inch to 1 inch in diameter; pH 6.4.

B_{2t} 12 to 30 inches, dark yellowish-brown (10YR 4/4) clay loam; very weak coarse subangular blocky structure, nearly massive; plastic, slightly sticky; contains many, dark-gray to black, soft, leached, calcareous pebbles ("ghosts") and a few strong-brown (7.5YR 5/8) silty ghosts; pH 6.6; calcareous in spots; wavy, tongued boundary.

C_2 30 inches +, gray coarse sandy gravel; structureless (single grained); loose when moist; coarse skeleton dominantly of pebbles ¼ inch to 2 inches in diameter, and some cobblestones 4 to 6 inches in diameter, mostly rounded and of shaly limestone; a few cobblestones have lost their original content of lime; many fragments of mollusk shells; calcareous.

Intrazonal soils

Intrazonal soils cover more than 90 percent of the area of the county. They are represented in Grand Isle County by the Brown Forest soils, the Low-Humic Gley soils, the Humic Gley soils, the Half-Bog soils, and the Bog soils.

BROWN FOREST SOILS

The Amenia, Benson, and Nellis soils are in the Brown Forest great soil group. These soils have an A_1–B_2–C horizon sequence. Their characteristics are determined to a significant extent by the nature of the parent material. These soils developed from calcareous material. In most areas they are leached of free carbonates to depths of 1½ to 2 feet. The carbonates in the parent material so near the surface retard podzolization. Soil fauna, mostly large earthworms, break down the leaf litter so rapidly that there is no chance for an organic mat to accumulate. Generally, each year's leaf fall is consumed within the year. The earthworms mix the organic matter with the mineral particles in the surface layer and even in the B horizon. They leave casts and channels, which fill up with dark-colored material from the A_1 horizon. The A_1 horizon is 3 to 7 inches thick and normally has a strong granular structure.

The Benson soils are representative of the Brown Forest soils. The following profile was observed on a 4-percent slope 1 mile southwest of Alburg Center.

Benson rocky silt loam, over shaly limestone, cultivated (all colors moist):

A_p 0 to 9 inches, very dark grayish-brown (10YR 3/2) silt loam; strong fine and medium granular structure; friable to very friable; numerous grass roots; 10 percent coarse skeleton of channery limestone fragments up to 1 inch long; some leached fragments; pH 6.8; abrupt, wavy boundary; 8 to 9 inches thick.

B_2 9 to 16 inches, dark yellowish-brown (10YR 3/4) channery silt loam; strong very fine subangular blocky structure; friable; many grass roots; many earthworm casts and channels; 30 percent coarse skeleton of channery limestone fragments up to 1 inch long; some leached fragments; pH 7.0; clear, wavy boundary; 6 to 10 inches thick.

C_2 16 to 21 inches, dark grayish-brown (10YR 4/2) very channery silt loam; weak fine and very fine granular structure; very friable; grass roots common; 95 percent coarse skeleton of channery and flaggy limestone fragments; slight effervescence with cold, dilute hydrochloric acid.

D_r 21 inches +, soft, dark-gray shaly limestone bedrock; grass roots in fissures; strong effervescence with cold, dilute hydrochloric acid.

The Benson soils that overlie shaly limestone are somewhat different from the other Brown Forest soils. They have darker colored A_1 horizons. Some have an A_1–B_2–C–D sequence of horizons, but where the soil is very shallow the sequence may be A_1–B_2–D or, less commonly, A_1–C–D. Where there is no B horizon, Benson soils are generally calcareous throughout and are actually members of the Rendzina great soil group.

LOW-HUMIC GLEY SOILS

The Low-Humic Gley great soil group is the most extensive group in the county. The somewhat poorly drained to poorly drained Covington, Kendaia, and Swanton soils are in this group. They have an A_1–A_{2g}–B_{2g}–C_g horizon sequence and have developed under the influence of fluctuating water tables. The soils of this group vary in texture, consistence, and structure, but the horizon sequence is common to all of them. In undisturbed areas, a thin layer of organic material rests on the topmost mineral horizon. Generally, most of this is consumed within a year by earthworms, which are numerous in these soils. The dark-colored A_1 horizon is 2 to 5 inches thick. It is underlain by a 4- to 8-inch, light-gray, faintly mottled A_{2g} horizon. Below this is a B_{2g} horizon that is distinctly mottled with gray, yellow, and strong brown. The mottles diminish with depth. Plowing mixes the A_1 and A_{2g} horizons, and in places part of the B_{2g} horizon. The color of the mixed layer varies from very dark grayish brown to black but most commonly is very dark brown. Generally, remnants of the A_{2g} horizon underlie the plow layer, especially in the sandy Swanton soils.

Low-Humic Gley soils develop by the process known as gleization. Organic matter falls on the surface and is incorporated with the nearly black A_1 horizon, probably by the action of fauna. During most of the year the water table is at or near the surface, and consequently the soil becomes deficient in oxygen. As water-soluble products of plant decomposition move down through the profile, they cause solution and reduction of the highly colored ferric oxide compounds. When the capacity of the water-soluble extract to dissolve ferric compounds is exhausted the ferrous iron is immobilized to some extent by adsorption on ferric oxide in lower horizons.[2] As the soil dries out in the summer, reoxidation of adsorbed ferrous iron occurs readily, producing yellowish, reddish, and brown colors. The greatest reduction takes place just under the surface horizon, where the water-soluble extract of plant remains from the A_1 horizon has the highest dissolving and reducing capacity. Most of the iron compounds are carried down and reoxidized below the A_{2g} horizon. The A_{2g} horizon is consequently less distinctly mottled than the horizons below. Nearer the surface, where organic matter is available to micro-organisms, anaerobic bacteria may supplement the purely chemical gleization process.

[2] BLOOMFIELD, C. EXPERIMENTS ON THE MECHANISM OF GLEY FORMATION. Jour. Soil Sci. 2: 196–211. 1951.

Apparently, microbial activity is not necessary for the gleying process to take place. In 1954, Bromfield showed that inoculated gleyed soil material from a depth of 10 feet did not result in bacterial growth nor reduction of ferric iron, whereas at depths of 2 feet the soil material, in about the same gleyed condition as at 10 feet, showed bacterial growth and reduction of ferric iron.

Because the water table is high at all times except during the growing season, there is not much downward percolation and leaching in Low-Humic Gley soils. For this reason, and also because the ground water tends to flow laterally, the Low-Humic Gley soils commonly have a slightly higher degree of saturation with exchangeable bases than the associated zonal soils, which are leached by downward movement of water. This is especially true of Swanton soils in contrast to the Brown Podzolic Elmwood and Melrose soils.

The Swanton soils are typical of the Low-Humic Gley great soil group. The following profile was observed on a 2-percent slope, 1¾ miles south by southwest of Alburg Center.

Swanton fine sandy loam, cultivated (all colors moist):

A_p 0 to 9 inches, black (5YR 2/1) fine sandy loam; moderate fine and medium crumb or granular structure; very friable; numerous grass roots; pH 6.5; abrupt, smooth boundary; 7 to 10 inches thick.

A_{2g} 9 to 11 inches, grayish-brown (2.5Y 5/2) loamy fine sand; common, fine and medium, distinct mottles of dark yellowish brown (10YR 4/4) and olive brown (2.5Y 4/4); massive or very weak medium platy structure that crushes to weak fine granules; very friable; grass roots common to few; pH 6.6; abrupt and clear, broken boundary; 0 to 3 inches thick.

B_{21g} 11 to 21 inches, dark grayish-brown (2.5Y 4/2) fine sandy loam or loamy fine sand; many, medium and coarse, distinct mottles of brown to dark brown (7.5YR 4/4) and dark grayish brown (10YR 4/2); weak medium platy structure that crushes to weak fine subangular blocks and some weak medium granules; very friable to friable; grass roots common to few; pH 6.6; clear, smooth boundary; 9 to 13 inches thick.

B_{22g} 21 to 27 inches, dark grayish-brown (2.5Y 4/2) fine sand; many, medium and coarse, distinct mottles of yellowish red (5YR 4/6) and dark reddish brown (5YR 3/3); massive—crushes to single grains and some very weak fine granules; friable; very few grass roots; pH 6.8; clear, wavy boundary; 2 to 6 inches thick.

B_{23g} 27 to 35 inches, grayish-brown to light olive-brown (2.5Y 5/3) fine sand; many, medium and coarse, prominent mottles of strong brown (7.5YR 5/6) and yellowish brown (10YR 5/6); massive; when dug into, it comes out in clods and crushes to single grains and very weak granules; friable, slightly firm in place; very few grass roots; pH 6.6; clear, wavy boundary; 5 to 8 inches thick.

C_2G 35 to 42 inches, dark-gray (N 4/0) fine and medium sand; a few medium, distinct, olive-brown (2.5Y 4/4) mottles; massive, crushes easily to single grains and some very weak fine crumbs; very friable; pH 6.9; abrupt, wavy boundary; 5 to 9 inches thick.

D_uG 42 inches+, gray (N 5/0) clay or clay loam; common, fine and medium, distinct, olive-brown (2.5Y 4/4) mottles; moderate very fine and fine subangular and angular blocky structure; firm; no grass roots present; pH 6.9.

HUMIC GLEY SOILS

Humic Gley soils occur in flat areas or depressions. Although the water table fluctuates, Humic Gley soils are saturated most of the time except in the middle of the growing season or in unusually dry weather. Generally, there is not much lateral movement of ground water. These soils develop by the process of gleization, which is described in the section on Low-Humic Gley soils.

The very poorly drained Lyons soils are the only Humic Gley soils in Grand Isle County. These soils have an A_1 horizon that is high in organic matter and is somewhat thicker and blacker than the A_1 horizon of the Low-Humic Gley soils. The horizon sequence may be A_1–G–CG, A_1–BG–CG, or A_1–B_{2g}–C_g. The A_{2g} horizon that occurs in the Low-Humic Gley soils is lacking. The matrix color of the subsoil is grayer than in soils of the Low-Humic Gley group. This is one of the criteria in differentiating Humic Gley from Low-Humic Gley soils in areas that have B_{2g} horizons.

The following profile, observed in a slightly depressed area 1¼ miles north of Alburg Springs, is representative of Humic Gley soils.

Lyons loam, pastured (all colors moist, except the A_1 horizon):

A_1 0 to 4 inches, very dark brown (10YR 2/2, dry) loam; high in organic matter; moderate medium granular structure; slightly hard; many roots of rushes; pH 6.4; abrupt, smooth boundary; 4 to 5 inches thick.

BG_{21} 4 to 14 inches, very dark gray (N 3/0) light loam; many, medium, distinct, grayish-brown (2.5Y 5/2) mottles and few, fine, distinct, light olive-brown (2.5Y 5/6) mottles; very weak fine and medium subangular blocky structure; firm to friable; roots of rushes common in the upper 5 inches and very few below; 10 to 15 percent coarse skeleton of channery fragments ⅛ inch or more long; pH 6.7; clear, wavy boundary; 9 to 11 inches thick.

BG_{22} 14 to 17 inches, dark-gray (N 4/0) very fine sandy loam; common, medium, faint, dark grayish-brown (2.5Y 4/2) mottles and few, distinct, olive-brown (2.5Y 4/4) mottles; weak thick platy structure; firm; few roots of rushes; no coarse skeleton; pH 7.2; clear, wavy boundary; 1 to 3 inches thick. This is possibly an A'_{2g} horizon.

BG_{3m} or CG_{1m} 17 to 25 inches, dark-gray (5Y 4/1) loam; many, medium, distinct, olive-brown (2.5Y 4/4) mottles; massive; very firm in place, firm in the hand; few or no roots of rushes; 10 to 15 percent coarse skeleton of channery fragments ⅛ inch long or longer; pH 7.2; clear, wavy boundary.

CG 25 inches +, dark-gray (N 4/0) fine sandy loam; few to common, medium, distinct mottles of brown to dark brown (10YR 4/3 and 7.5YR 4/4); weak thick platy structure; friable; no roots; 10 to 15 percent coarse skeleton of channery fragments about ⅛ inch long; strong effervescence with cold, dilute hydrochloric acid.

The B horizon has some weathered limestone "ghosts" and 3- to 6-inch cobblestones, some of limestone.

HALF-BOG SOILS

In low areas where surface water accumulates or the ground water is at or on the surface most of the year, Half-Bog soils are formed. Though these soils develop through gleization, the genetic horizon sequence differs from those of the Low-Humic Gley and the Humic Gley groups. The soils of the Livingston and Whately series are in this group; they have hydromorphic characteristics and an O–G horizon sequence. To a certain degree, the accumulated organic matter is preserved from rapid oxidation by the excess water. A mucky O horizon develops that ranges from 1 to about 18 inches in thickness. The organic layer is underlain by mineral horizons of various textures, in which ferric iron is highly reduced by water soluble organic compounds. These mineral horizons are bluish gray and are mottled faintly or not at all.

If the source of the water is a high water table, the soil may be bluish gray to great depths; if the source is accumulated surface water, the uppermost 1 to 2 feet of soil may be highly reduced and have G horizons, but the underlying soil may be less reduced and have grayish-brown matrix colors. In the latter instance the horizon sequence would be O–G–B_g or O–G–C_g. In areas that have G horizons, the mottling, if any, is generally faint. In places, the mottles are threadlike and occur as concentric brownish rings around the remains of plant roots.

The following profile, observed in a depressed area 1¾ miles south of Alburg Center, is representative of Half-Bog soils.

Livingston silty muck, pastured (all colors moist):

O_1 0 to 11 inches, black (10YR 2/1) silty muck; weak medium granular structure; very friable; many sedge roots; pH 6.6; abrupt, wavy boundary; 11 to 13 inches thick.

G_1 11 to 15 inches, dark-gray (5Y 4/1) silty clay; very weak fine subangular blocky structure to massive; slightly sticky, plastic; few sedge roots; pH 7.2; abrupt, smooth boundary; 3 to 6 inches thick.

G_2 15 to 32 inches, gray (N 5/0) silty clay; many, fine, prominent, yellowish-brown (10YR 5/6) mottles; weak medium subangular blocky structure; slightly sticky, plastic; no roots; pH 7.2.

CG 32 inches +, gray (N 5/0) silty clay loam; common, medium, faint, olive-gray (5Y 5/2) mottles; massive; slightly sticky, plastic; pH 7.2 +; not calcareous with cold, dilute hydrochloric acid.

BOG SOILS

The Bog soils have developed in undrained depressions or flats. They are composed mainly of organic materials. Trees, shrubs, rushes, and other water-tolerant plants growing in small ponds and in large areas of shallow water near Lake Champlain die and sink to the bottom, where thick layers of plant remains build up until they reach the surface of the water.

Where these plant remains are recognizable, the deposits are known as peat. Balch is the only series of peat soils in this county. Where the organic materials are decomposed enough so that it is not possible to recognize the original plant remains, they are known as muck. Carlisle is the only series of muck soils in Grand Isle County.

Carlisle muck is the most extensive of the Bog soils in the county. It supports swamp hardwoods, such as red maple and American elm. Balch peat supports mostly conifers, such as black spruce, tamarack, and some white pine.

Fresh water marsh is apparently an organic soil. It has not been studied because the areas are under shallow water most of the time. The soil probably contains a considerable amount of mineral matter mixed with organic matter and, because of flooding, may have some characteristics of Alluvial soils. Most areas are not now forested.

Bog soils have an O–DG sequence of horizons. They differ from Half-Bog soils principally in the depth of the mucky or peaty surface horizon.

The following profile of Carlisle muck was observed in the town of Alburg, ¼ mile west of Mud Creek and ¾ mile south of the United States-Canada border. It is representative of Bog soils.

Carlisle muck, forested (all colors moist):

O_1 0 to 9 inches, black (10YR 2/1), well-decomposed, spongy deposit of deciduous and coniferous forest detritus; moderate medium granular structure; slightly sticky but not plastic; pH 6.8; lower boundary clear.

O_2 9 to 36 inches, black (5YR 2/1), well-decomposed forest vegetation; massive; 10 to 20 percent is undecomposed or partially decomposed woody vegetation; pH 6.8.

O_3 36 to 40 inches, same as O_2 layer, except that the color is somewhat browner (5YR 2/1–2/2) and the percentage of undecomposed woody vegetation may be somewhat higher.

D_u 40 inches+, dark-gray (N 4/0) silt loam; slightly sticky but not plastic; pH 7.0; color of this horizon was bluish to the eye.

History and Development of the County

The aboriginal occupants of this part of the country were Abnaki Indians. They were driven out by Iroquois Indians, who invaded the territory during the colonial wars between the French and the English. The first white explorers and settlers were French. In 1609, Samuel de Champlain first visited the lake now known by his name. In 1666, the French built Fort Ste. Anne, on Isle La Motte, as an outpost of their settlements along the Richelieu River. From this outpost they launched raids against the Iroquois.[3]

The French established settlements at Windmill Point as early as 1731 but, because of war, soon abandoned them. In 1779, all of Grand Isle County except Isle La Motte and Alburg was granted to General Ethan Allen and Colonel Ira Allen and their associates. In 1781, the legislature of Vermont granted Alburg to Ira Allen and his associates. Both the Allens were considered heroes of the Revolution, and accordingly the towns of North Hero and South Hero were named for them. About 1782, some immigrants from St. Johns, Canada, settled within the limits of the town of Alburg, which was then known as Caldwell's Upper Manor. These settlers, mostly British refugees, supposed themselves to be in Canada. This led to many lawsuits, in the course of which Alburg was claimed, at one time or another, by England, New York, and Vermont. The grant to Ira Allen stood the test of law, and under it the inhabitants held their land.

During the War of 1812, the British sailed a fleet up Lake Champlain in 1814, landed men at Isle La Motte, and claimed jurisdiction over the island. From this island the British sailed on September 11, 1814, to the Battle of Plattsburg, where they were defeated by the Americans.

Organization and Population

Isle La Motte was organized as a town in 1791. The people of Alburg took the Freeman's Oath in 1792 and organized a town government under the authority of the State of Vermont. Under an act passed by the Vermont General Assembly in 1802, the towns of Alburg, Isle La Motte, North Hero, South Hero, and Middle Hero (later changed to Grand Isle) formed Grand Isle County.

In 1950, the population of Grand Isle County was 3,406—396 less than in 1940. The average population per square mile is 44 persons. About half the people live on farms, and the rest live in small villages. The whole population is classified as rural.

[3] HEMENWAY, A. M. THE VERMONT HISTORICAL GAZETTEER. Vol. II, 1951 pp. 1871.

Natural Resources

Water.—The main source of water is Lake Champlain. Water for all of the villages is pumped from the lake. Some groups of farmers have formed water cooperatives to pipe lake water to their farms. Springs are uncommon, although early historical accounts tell of Iodine Spring in South Hero, Alburg Spring, and other "mineral springs" that were thought to possess medicinal properties. Shallow wells are common. They go dry in droughty years. Wells that are at least 125 feet deep are reliable. In some of the deep wells, the water is very hard and contains large amounts of lime and magnesia. Many farmers who cannot avail themselves of soft water from the lake have cisterns to catch and store rainwater.

Rock deposits.—The county has considerable deposits of limestone suitable for building material and of black marble, which is used for building material and ornaments.

Wildlife.—Early records mention bear, wolf, lynx, catamount, and beaver. Except for beaver, these animals have vanished from the county. Red fox, gray squirrel, and raccoon are plentiful. Cottontail and snowshoe rabbits, muskrats, and mink are scarce. There are hardly any deer in the county.

Duck hunting attracts many sportsmen to Grand Isle County. The long shoreline, with its many bays, freshwater marshes, and low swampy areas, draws black ducks, mallards, wood ducks, baldpates (widgeons), and blue-winged and green-winged teals. Diving ducks, commonly called lakers, usually fly into this area in the latter part of October as they migrate from Canada. They are whistlers (American goldeneye), bluebills (greater and lesser scaup), ring-necked ducks (ringbills), and buffleheads. Among the plentiful fish ducks are hooded, red-breasted, and American mergansers. Canada geese fly over in great numbers and occasionally land in the fields to feed on clover, corn, and grain.

Some ruffed grouse, or partridge, are seen in the woods all over the county, especially in the northern part. Hungarian partridge are newcomers to the county. They are not native to Vermont, and it is thought that they have migrated from either Canada or New York.

Grand Isle County is in the midst of some of the best fishing waters in northeastern United States. Yellow perch, many 12 to 16 inches long and weighing a pound or more, are taken in large quantities. Walleyed pike provide excellent fishing early in spring as they migrate to their spawning beds. Many 3- and 4-pounders are brought to net, and occasionally a 10-pounder is landed. Smallmouthed bass are more plentiful than largemouthed bass. Two pounds is about the average size for a smallmouthed bass, although occasionally a 4- to 5-pounder is caught. Northern pike, which weigh 3 to 5 pounds, are the largest fish commonly caught in Lake Champlain. Now and then a 15-pounder is caught. A few sturgeon are netted. A special license is required. The sturgeon are highly prized for their roe, which is sold as caviar. Sturgeon weighing more than 150 pounds have been netted.

Industries

Grand Isle County is primarily agricultural, and most of its inhabitants depend directly or indirectly upon agriculture for their livelihood. About 25 percent are farmers and farm operators. Among those engaged in service to the farmers are professional people, merchants, clerks, salesmen, mechanics, and farm wage workers. A small number of people—fishing and hunting guides and owners of motels and summer camps—make their living by serving campers and tourists.

Two creameries, one at Alburg and one at Grand Isle, process milk for shipment to the Boston fluid milk market. Several marble quarries have been opened and operated in the past. Only one quarry is operating now and that on part time. It is in Isle La Motte and produces black marble that is used for ornamental purposes. At one time, probably more limestone for building was quarried in Isle La Motte than in any other part of Vermont. The piers of the Brooklyn Bridge and of the Victoria Bridge at Montreal are mainly of this limestone.

The largest frogging industry in Vermont, and probably in the northeastern United States, is centered in Alburg. In 1955, about 800,000 pairs of frogs legs were shipped to all parts of the United States, Canada, and other countries. About 200,000 frogs and 10,000 toads were shipped alive to medical colleges, hospitals, and laboratories for research. Some of the frogs and toads were caught in the Champlain Valley part of Addison and Franklin Counties, and some in Canada.

Transportation and Markets

Travelers have neither bus nor railroad service in the county. The freight line of the Rutland Railway extends the length of the county from north to south. It connects with the Canadian National Railway and the Central Vermont Railway at Alburg. United States Highway No. 2 passes through the county from north to south. It is the main artery of transportation. All of the farms are connected with this highway by gravel or dirt roads. Alburg and the three large islands are connected by modern bridges. Bridges also connect the county with the mainland of Vermont and New York.

Milk is collected daily and shipped by rail or tank truck to the cities, mostly to Boston. Apples and hay are also shipped out by truck.

Farm and Home Facilities

Most of the 302 farms in the county have modern conveniences and equipment. Practically all have electricity, and a majority have telephones and running water. According to the 1954 Census of Agriculture, there were 155 motortrucks on 125 farms, 380 tractors on 245 farms, and 345 automobiles on 255 farms. Electric milking machines were used on 210 farms. In many farm homes there were television sets and home freezers.

Agriculture

Because of the moderating effect of the waters of Lake Champlain, Grand Isle County has a longer growing season (about 160 days) than any other part of the State. It receives less rain and snow than other parts of the State, but enough to supply moisture for crops. The rainfall is fairly well distributed through the growing season.

The Indians who occupied what is now Grand Isle probably raised a little corn, but they subsisted mainly

by hunting and fishing. The early settlers cleared some of the land and raised wheat, oats, corn, buckwheat, and Irish potatoes. They also grew some barley, beans, and peas. Fruit, mostly the hardy varieties of apples, pears, cherries, and grapes, was fairly important during the 1800's.

During the middle and late 1800's, sheep raising became fairly extensive, and the sale of wool was an important source of farm income. In 1860, there were 13,644 sheep and only 1,525 milk cows in the county. At this time grain and potatoes were the principal crops. More than 34,000 acres was classed as "improved land".

By 1954, dairying was the main agricultural enterprise. It accounted for 77 percent of the income. All other livestock, including poultry, accounted for only 10 percent. The number of cattle in the county had increased to 9,358. The average milk production per farm in 1954 was 151,914 pounds, an increase of 23 percent since 1950. As the number of cattle increased, the number of horses, hogs, and sheep decreased.

Today, the principal crops are those that provide feed for dairy cattle. The common rotation is corn, grain, and hay or pasture. The acreage of hay crops has increased steadily. Alfalfa, which gives good yields on the limestone soils, is an increasingly important hay crop. More and more grass is used for silage. Corn is grown chiefly for silage. Oats is the most important small grain. Rye and winter wheat are often grown for cover crops. They make fine pasture early in spring. Irish potatoes are now grown almost entirely for home consumption. Those not used on the farm where they are grown are sold locally. Fruit, primarily apples, is second to dairying as a source of farm income. In 1954, fruit accounted for 10 percent of the total farm income. The changes in acreage of the principal crops in recent years are shown in table 6.

TABLE 6.—*Acreage of principal crops and number of bearing apple trees in stated years*

Crops	1929	1939	1949	1954
Hay:	*Acres*	*Acres*	*Acres*	*Acres*
Alfalfa and alfalfa mixtures	1, 774	3, 665	4, 046	5, 540
Clover, timothy, and mixtures of clover and grasses	10, 301	8, 569	6, 910	5, 587
Oats, wheat, barley, rye, or other small grains cut for hay	42	393	978	305
Grass silage (grasses, alfalfa, clover, or small grains)	(1)	(1)	159	772
Corn:				
For all purposes	2, 129	2, 150	2, 384	2, 345
Cut for silage	1, 230	1, 686	2, 306	2, 238
Small grains:				
Grown together	(1)	1, 403	361	228
Oats	1, 685	1, 414	889	904
Other grains	531	688	329	217
	Number	*Number*	*Number*	*Number*
Apple trees	[2] 36, 769	[2] 21, 851	[2] 19, 979	9, 968

[1] Not reported.
[2] One year later than year given at head of column.

The production of crops has increased through the use of fertilizers, better varieties of crops, better choice of livestock, and proper land use.

Except for the sandy soils, the soils of Grand Isle County are naturally high in lime. Leaching may cause the plow layer to become acid, however. In 1954, 935 tons of lime was spread on 1,570 acres on 55 farms.

Table 7 shows the amounts of commercial fertilizer used on pastures and the principal crops in 1954.

TABLE 7.—*Commercial fertilizer used in 1954*

Crops	Tons of fertilizer	Acres	Number of farms
Hay and cropland pastured	536	1, 605	75
Other pasture	30	110	15
Corn	138	720	65
Fruits and vegetables	96	125	5
Other crops	52	270	30

In 1954 there were 45,348 acres in farms. Of this, 36,247 acres was cleared. The number of farms decreased from 501 in 1920 to 302 in 1954. In the same period, the average size of the farms increased from 96 acres to 150 acres. According to the 1954 Census of Agriculture, the numbers of farms of different sizes were as follows:

Size in acres:	*Number of farms*
Less than 10	24
10 to 99	87
100 to 259	146
260 to 499	39
500 to 999	6
Total	302

Four-fifths of the farms were classified as commercial. Five were classified as part-time farms and the rest as residential farms.

Farm tenancy is decreasing. In 1920, 37 percent of the farms were occupied by tenants; in 1954, only 13 percent. Of the tenants, 7 were cash tenants, 4 were sharecroppers, 23 were livestock-share tenants, and 5 were unspecified.

Physiography

Grand Isle County was covered by the Labrador Ice Sheet of the late Wisconsin glaciation. The ice sheet is estimated to have been roughly 10,000 feet thick.[4] During the wastage of the ice, according to D. H. Chapman,[5] the Champlain Valley was occupied by an ice lobe fed from the north, while the highlands to the east and west were free of ice. The uplift of the Hudson Valley formed a new glacial lake (Lake Vermont) in the southern end of the Champlain Valley. As the ice receded, Lake Vermont grew and submerged the present Grand Isle County and most of the valley between the Adirondacks and the Green Mountains. The lake drained southward into the Hudson Valley. Probably it merged with Lake Frontenac. As the ice margin shrank away from the south side of the St. Lawrence Lowland, a connection with the sea was opened along the lower St. Lawrence, and sea water flooded the valley as far south as Whitehall, New York.[6] The present Lake Champlain was formed when differential uplift brought the northern end of the Champlain Valley

[4] *See* footnote 1, p. 32.
[5] JACOBS, E. C. REPORT OF THE STATE GEOLOGIST ON THE MINERAL INDUSTRIES AND GEOLOGY OF VERMONT. 83 pp. 1941–1942.
[6] FLINT, R. F. GLACIAL GEOLOGY AND THE PLEISTOCENE EPOCH. p. 263. 589 pp., illus. 1947.

out of the sea more rapidly than the southern end and cut the valley off from the sea.

Geology.—The county is underlain by Ordovician rock. Most of it is Canajoharie shale,[7] a calcareous, brittle, thin-bedded, rather soft rock, generally black and in places banded with gray or light brown. This rock occurs throughout the county, except in the town of Isle La Motte, on some of the small islands in the eastern part of the county, and in a narrow band along the western part of the town of South Hero. In this county, the only residual soil is in the areas underlain by Canajoharie shale.

The town of Isle La Motte and the western part of the town of South Hero are underlain by hard, massive limestone of the Trenton, Black River, Chazy, or Beekmantown groups. Chazy limestone is varicolored, very dense, and hard. Black River limestone is compact, hard, and brittle; most of it is black but some is grayish or drab. Beekmantown limestone and dolomite is a hard, very siliceous, thin-bedded rock. Trenton limestone is light to dark gray and may be thin bedded or thick bedded.

Topography.—The topography of Grand Isle County is predominantly flat to gently undulating. About 60 percent of the county has slopes of less than 3 percent, about 31 percent has slopes of 3 to 8 percent, and the remaining 9 percent has slopes of 8 to 60 percent. Only a small part of the county has slopes of more than 25 percent. There are a few hills more than 100 feet high, but most of the county consists of small hillocks, 20 to 40 feet high, interspersed with low level areas. The highest spot in the county is 1½ miles northeast of Grand Isle village. The elevation at this point is 280 feet above sea level, or 180 feet above the level of Lake Champlain. The extensive shoreline consists of many shaly cliffs, 20 to 30 feet high, alternating with a few sandy beaches and low level areas.

Drainage.—Grand Isle County does not have a well-developed natural drainage system. There is only one creek, which flows south out of Canada into the eastern part of the town of Alburg. It meanders through a low swampy area and empties into Lake Champalin. Much of the water in and on the soils is carried off by open, man-made ditches. Because many areas are at or below lake level and have no drainage outlets, many of the soils are poorly drained.

Engineering Applications[8]

The purpose of this section is to present the kind of information about the soils that will help engineers to decide on the location, design, and construction of highways, airfields, and other engineering structures, and to select sites for industrial, municipal, and recreational developments.

The ability of an engineer to estimate from this report the engineering properties of a soil depends upon his knowledge of (1) the pedological classification system used by soil scientists, (2) the physical and environmental characteristics of the soils, and (3) the engineering problem being considered.

These soil survey reports contain information that can be used in:

(1) Making studies of soil and land use.

(2) Making preliminary estimates of runoff and erosion characteristics, for use in designing drainage and irrigation systems and in planning dams and other structures for water and soil conservation.

(3) Making reconnaissance surveys of soil and ground conditions and planning detailed soil surveys for the intended locations.

(4) Locating sand and gravel for use in structures.

(5) Developing information that will be useful in designing and maintaining pavements.

(6) Determining the suitability of soils for cross-country movements of vehicles and construction equipment.

(7) Supplementing other sources of information for making engineering soil maps and reports.

The map and the descriptive report are somewhat generalized and should be used only in planning more detailed field surveys to determine the in-place condition of the soil at the site of the proposed engineering construction.

Soil Science Terminology

Some of the terms used by the agricultural soil scientist may have special meanings that are unfamiliar to the engineer. These terms are defined as follows:

Soil: The natural medium for the growth of land plants on the surface of the earth; composed of organic and mineral materials.

Clay: As a soil separate, mineral particles less than 0.002 mm. in diameter. As a textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Silt: As a soil separate, mineral particles 0.05 mm. to 0.002 mm. in diameter. As a textural class, soil material that contains 80 percent or more silt and less than 12 percent clay.

Sand: As a soil separate, mineral particles 2.0 mm. to 0.05 mm. in diameter. As a textural class, soil material that contains 85 percent or more sand, and the percentage of silt plus 1½ times the percentage of clay shall not exceed 15.

Topsoil: Presumably fertile soil material used to topdress roadbanks, gardens, and lawns.

Aggregate: A cluster of primary soil particles held together by internal forces to form a clod or fragment.

Granular structure: Individual grains grouped into spherical aggregates with indistinct sides. Highly porous granules are commonly called crumbs.

Soil Test Data and Engineering Soil Classifications

To be able to make the best use of the soil maps and soil survey reports, the engineer should know the physical properties of the soil materials and the in-place condition of the soil. After testing soil materials and observing the behavior of soils when used in engineering structures and foundations, the engineer can recommend designs for structures on specific soils.

Soil test data

Table 8 contains engineering test data for 9 soil profiles, 3 from the Covington series, 3 from the Kendaia series, and 3 from the Swanton series. The samples were

[7] STONE, D. S. ORIGIN AND SIGNIFICANCE OF BRECCIAS ALONG THE NORTHWESTERN SIDE OF LAKE CHAMPLAIN. Jour. Geol. 65: 85–87. 1957.

[8] This section was prepared by Jesse R. Chaves, highway research engineer, Division of Physical Research, Bureau of Public Roads. Test data in table 8 were obtained from the Soils Laboratory, Bureau of Public Roads.

taken from profiles representing the central concept of the series (modal) as well as from those representing extremes in either texture (grain size) or depth of profile development. Those for the Covington series had surface layers of loam or silt loam; they represent inclusions in Covington silty clay loam. Because there is considerable variation in glacial deposits, the test data for a mapping unit may not necessarily apply throughout that unit. The soils were tested in accordance with standard procedures established by the American Association of State Highway Officials (see footnote 4, table 8). All samples were taken at depths of less than 5 feet.

The engineering soil classifications in table 8 are based on data obtained by mechanical analyses and by liquid-limit and plastic-limit tests.

The mechanical analyses were made by combined sieve and hydrometer methods. The percentage of fragments larger than 3 inches in diameter was estimated in the field and not included in samples submitted for analysis. The percentage of clay obtained by the hydrometer method should not be used in naming agricultural soil textural classes.

The liquid-limit and plastic-limit tests measure the effect of water on the consistence of the soil material. As

TABLE 8.—*Engineering test data [1] for*

Soil name and location of sample	Parent material	Bureau of Public Roads report no.	Depth	Horizon	Moisture-density: Maximum dry density	Moisture-density: Optimum moisture	Estimated percentage larger than 3 inches discarded in field sampling
			Inches		*Lb. per cu. ft.*	*Percent*	
Covington silt loam:							
1 mile SW. of Long Point, near shore of Lake Champlain. (Central concept.)	Marine sediments	S31544	0–7	A_p	95	23	----------
		S31545	9–21	B_{2g}	91	29	----------
		S31546	28+	C_2	87	32	----------
Covington loam or silt loam:							
0.9 mile S. of Isle La Motte, 100 yards S. of The Marsh. (Sandy subsoil.)	Marine sediments	S31547	0–8	A_p	97	21	----------
		S31548	18–31	B_{22gu}	117	14	----------
		S31549	31–55	D_{1g}	117	14	----------
Covington loam:							
1 mile S. of Grand Isle, 100 feet W. of U. S. 2. (Shallow to glacial till.)	Marine sediments	S31550	0–6	A_1	89	26	----------
		S31551	12–20	B_{22g}	92	27	----------
		S31552	24+	D_{2g}	124	11	----------
Kendaia very stony silt loam:							
1.5 miles NE. of North Hero-Alburg Bridge. (Central concept.)	Glacial till	S31553	0–6	A_p	96	23	5
		S31554	9–16	B_{3g}	124	10	5
		S31555	23+	C_{2mg}	125	10	5
1 mile NW. of Grand Isle. (Clayey subsoil.)	Glacial till	S31559	0–7	A_p	83	31	18
		S31560	7–14	B_{21g}	111	16	18
		S31561	20–28	C_g	123	11	8
Kendaia silt loam:							
1.25 miles W. of East Alburg. (Sandy subsoil.)	Glacial till	S31556	0–6	A_p	101	19	3
		S31557	8–14	B_{2g}	123	11	5
		S31558	27+	C_{2mg}	126	9	5
Swanton fine sandy loam:							
1 mile W. of Little Bluff Point. (Central concept.)	Marine sediments	S31562	0–9	A_p	101	18	----------
		S31563	11–21	B_{21g}	115	12	----------
		S31564	42+	DG	99	22	----------
1.25 miles NW. of South Hero. (No C horizon.)	Marine sediments	S31565	0–12	A_p	106	17	----------
		S31566	15–20	B_{2g}	122	12	----------
		S31567	20–36	D_{1g}	118	14	----------
1 mile S. of Alburg Center, 100 yards E. of U. S. 2. (Very sandy.)	Marine sediments	S31568	0–9	A_p	96	21	----------
		S31569	13–19	B_{2g}	109	13	----------
		S31570	22+	D_{2g}	108	17	----------

[1] Tests performed by Bureau of Public Roads in accordance with standard procedures of the American Association of State Highway Officials, as described in Standard Specifications for Highway Materials and Methods of Sampling and Testing, ed. 7, pt. II, illus. 1955.

[2] Mechanical analyses according to the American Association of State Highway Officials Designation: T 88–54. Results by this procedure frequently differ somewhat from results that would have been obtained by the procedures of the Soil Conservation Service. In the A.A.S.H.O. procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material in the soil sample, including that coarser than 2 mm. in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 mm. in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming texture classes for soils.

moisture is added to a very dry clayey soil, the material changes from a solid to a semisolid or a plastic state. As more moisture is added, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material passes from a solid to a plastic state. The liquid limit is the moisture content at which the material passes from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is in a plastic condition.

Table 8 also gives compaction (moisture-density) data for the tested soils. If a soil material is compacted at successively higher moisture contents, assuming that the compactive effort remains constant, the density of the compacted material will increase until the "optimum moisture content" is reached. After that, the density decreases with increase in moisture content. The highest dry density obtained in the compaction test is termed "maximum dry density." Moisture-density data are important in earthwork, for, as a rule, optimum stability is obtained if the soil is compacted to about the maximum dry density when it is at approximately the optimum moisture content.

soil samples taken from nine soil profiles

Mechanical analysis [2]															Liquid limit	Plasticity index	Classification	
Percentage passing sieve [3]											Percentage smaller than [3]						A.A.S.H.O.[4]	Unified [5]
3-in.	2-in.	1½-in.	1-in.	¾-in.	⅜-in.	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 60 (0.25 mm.)	No. 200 (0.074 mm.)	0. 05 mm.	0. 02 mm.	0. 005 mm.	0. 002 mm.				
----	----	100	99	99	99	99	98	94	90	79	76	65	47	33	48	17	A-7-5(12)	ML or OL.
----	----	------	----	----	----	------	100	99	98	96	96	90	82	72	66	34	A-7-5(20)	MH-CH.
----	----	------	----	----	----	------	100	99	99	97	96	91	88	82	80	46	A-7-5(20)	MH-CH.
----	----	------	----	----	----	------	------	------	100	85	70	40	24	20	41	12	A-7-6(9)	ML or OL.
----	----	------	----	----	----	------	------	------	100	91	74	37	21	17	24	4	A-4(8)	ML-CL.
----	----	------	----	----	----	------	100	99	99	85	69	37	24	20	27	8	A-4(8)	CL.
----	----	------	100	99	99	99	98	95	90	66	64	54	42	31	47	15	A-7-5(9)	ML or OL.
----	----	100	99	99	99	99	95	94	93	89	88	83	78	70	66	36	A-7-5(20)	CH.
----	100	98	96	95	94	91	87	79	75	59	53	38	22	14	20	5	A-4(5)	ML-CL.
95	----	------	95	94	94	93	92	88	86	73	69	51	32	22	44	15	A-7-5(11)	ML.
95	----	95	94	93	93	92	89	83	79	61	54	34	16	10	18	3	A-4(6)	ML.
95	----	------	95	94	93	91	87	80	75	59	52	31	15	10	16	1	A-4(5)	ML.
82	----	------	----	----	82	81	80	73	62	54	52	45	33	22	60	17	A-7-5(12)	MH or OH
82	----	82	80	79	77	75	70	62	52	43	42	38	29	21	36	15	A-6(5)	CL.
92	----	92	91	90	89	87	84	76	71	54	50	38	23	16	22	7	A-4(5)	ML-CL.
97	97	93	93	92	91	91	90	86	82	61	53	35	23	17	37	11	A-6(6)	ML-CL.
95	----	------	95	94	93	91	88	82	77	52	45	32	21	16	22	7	A-4(4)	ML-CL.
95	----	95	93	92	91	88	85	76	70	50	44	25	13	9	16	2	A-4(4)	ML.
----	----	------	----	----	----	------	100	99	98	49	35	20	13	9	30	4	A-4(3)	SM-SC.
----	----	------	----	----	----	------	------	100	99	49	35	18	15	12	20	1	A-4(3)	SM.
----	----	------	----	----	----	------	------	100	99	95	92	82	68	56	54	30	A-7-6(19)	CH.
----	----	------	----	----	----	100	99	98	96	53	46	32	25	19	30	7	A-4(4)	ML-CL.
----	----	------	----	----	----	------	------	100	99	53	44	30	25	20	22	7	A-4(4)	ML-CL.
----	----	------	100	99	99	99	98	96	94	68	58	41	31	25	28	12	A-6(7)	CL.
----	----	------	----	----	----	------	------	100	99	38	29	23	16	11	35	6	A-4(1)	SM.
----	----	------	----	----	----	------	------	------	100	21	15	14	12	8	NP	[6] NP	A-2-4(0)	SM.
----	----	------	----	----	----	------	100	99	99	93	88	66	42	32	40	19	A-6(12)	CL.

[3] Based on total material. Laboratory test data corrected for amount discarded in field sampling.

[4] Based on A.A.S.H.O. Designation: M 145-49, The Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes, published in Standard Specifications for Highway Materials and Methods of Sampling and Testing, ed. 7, pt. I, illus. 1955.

[5] Based on the Unified Soil Classification System, Tech. Memo. 3-357, v. 1, Waterways Experiment Station, Corps of Engineers.

[6] NP=Nonplastic.

Engineering classification systems

Most highway engineers classify soil materials in accordance with the system approved by the American Association of State Highway Officials. In this system, soil materials are classified in seven principal groups. The groups range from A-1, consisting of gravelly soils of high bearing capacity, through A-7, consisting of clay soils having low strength when wet. Within each group, the relative engineering value of the soil material is indicated by a group index number. Group indexes range from 0 for the best materials to 20 for the poorest. The group index number is shown in parentheses, following the soil group symbol, in the next to last column of table 8. The principal characteristics according to which soils are classified in this system are shown in table 9.

Some engineers prefer to use the Unified soil classification system established by the Corps of Engineers, Waterways Experiment Station (see footnote 5, table 8). In this system, soil materials are identified as coarse-grained (8 classes), fine-grained (6 classes), or highly organic. The principal characteristics of the 15 classes of soil are given in table 10. The classification of the tested soils according to the Unified system is given in the last column of table 8.

Soil Engineering Data and Recommendations

Some of the engineering information can be obtained from the soil map. It will be necessary, however, to refer to the text of the report, particularly to the sections Soil Survey Methods and Definitions, General Soil Areas, and Formation and Classification of Soils.

A summary of the principal soil characteristics significant to engineering is given in table 11. Map symbols and soil names are listed alphabetically in this table.

Table 12 shows some of the estimated physical and chemical properties for the soil series in this county. The properties listed have been determined by interpreting the soil survey data. They are those of the typical profile for the given soil series. The ratings were determined from information obtained from the soil survey report, from soil test data in table 8, and from experience with similar soils in other counties.

The glacial till soils contain many large stones, which interfere with the preparation of the finish, or surface layer, of the earth structure. Soils that have a stony surface layer are shown on the soil maps as "very stony phases." In some parts of the county, stones and boulders have been removed from the ground surface but are still to be found in the lower part of the soil profile.

Many construction projects will involve excavation of bedrock, as the glacial deposits are rather shallow. In constructing roads, the gradeline should be kept high, to minimize the need for bedrock excavation and also to avoid seepage at the boundary between the soil and the bedrock. Adequate systems of surface drainage and underdrainage should be provided, and coarse-grained soil materials should be used in the upper part of the subgrade. The sedimentary formations underlying the county are Canajoharie shale, Chazy limestone, Black River limestone, Beekmantown limestone and siliceous dolomite, and Trenton limestone. The limestone and dolomite have to be blasted. In some places, however, the bedrock is soft or shattered.

TABLE 9.—*Classification of soils by American*

General classification	Granular materials (35 percent or less passing No. 200 sieve)						
Group classification	A-1		A-3	A-2			
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7
Sieve analysis: Percent passing:							
No. 10	50 maximum.						
No. 40	30 maximum.	50 maximum.	51 minimum.				
No. 200	15 maximum.	25 maximum.	10 maximum.	35 maximum.	35 maximum.	35 maximum.	35 maximum.
Characteristics of fraction passing No. 40 sieve:							
Liquid limit			NP [2]	40 maximum.	41 minimum.	40 maximum.	41 minimum.
Plasticity index	6 maximum.	6 maximum.	NP [2]	10 maximum.	10 maximum.	11 minimum.	11 minimum.
Group index	0	0	0	0	0	4 maximum.	4 maximum.
Usual types of significant constituent materials.	Stone fragments, gravel, and sand.	Stone fragments, gravel, and sand.	Fine sand.	Silty gravel and sand.	Silty gravel and sand.	Clayey gravel and sand.	Clayey gravel and sand.
General rating as subgrade.	Excellent to good					Fair to poor	

[1] Based on A.A.S.H.O. Designation: M 145-49, The Classification of Soils and Soil-Aggregate Mixtures for Highway construction Purposes, published in Standard Specifications for Highway Materials and Methods of Sampling and Testing, ed. 7, pt. I, illus. 1955.

Frost action is a cause of engineering problems in this county. The soils may freeze to a depth of 5 feet or more. The soils most affected by frost action are those that have (1) a perched water table and a high content of fine sand or silt over clay, silty clay, or shale or (2) a high water table and a high content of fine sand or silt extending to a considerable depth. Frost damage to pavements or structures depends upon the location of the gradeline in relation to the water table and the surface of the ground. The susceptibility of the soils to frost action is summarized in table 12.

It is advisable to suspend earthwork during winter, to avoid using frozen materials in fills and embankments. Earthwork can be continued in free-draining sandy and gravelly soils and in soils that are shallow over bedrock.

The suitability of each soil for winter grading (table 12) is determined by drainage, grain size, and depth to bedrock. The rating is for the soil material, not for the bedrock.

The suitability of each soil as a source of topsoil for embankments, ditches, and cut slopes is also given in table 12. Soils that are rated poor or not suitable are either too wet, too stony, or too shallow, or they consist mostly of sand or organic matter. The ratings are for nonstony phases, and are based on inherent fertility, response to fertilizer, drainage, depth, and content of stones. Normally only the surface layer is used.

Most of the soils are susceptible to frost heave. A layer of free-draining materials thick enough to prevent heaving of the pavement should be used in the subgrade. Pockets of fine-grained soil materials in the coarse-grained moraine can cause differential frost heave. This can be prevented either by mixing the fine-grained and the coarse-grained materials to produce uniform heaving, or by using a thick enough layer of very sandy gravel or coarse sand in the upper part of the subgrade.

A perched water table occurs in the Elmwood, Melrose, and Swanton soils and may occur in the Amenia and Kendaia soils. Before roads are constructed on these soils, engineers should make a survey to determine the need for underdrains. In level or nearly level areas, the soils can be drained by building side ditches or by raising the grade if no drainage outlet is available.

Seepage in the backslopes of roadcuts may cause the soil to slump or slide. If the water table is only slightly below the pavement, differential volume changes may occur, particularly within the freezing zone, and the decrease in bearing capacity of the saturated or thawed foundation material may cause deterioration of the pavement. To prevent this, pockets of wet, fine-grained soil material within the foundation zone of the pavement should be removed and replaced with coarse-grained material.

Marine and glaciolacustrine silts and clays (Covington, Livingston, and Vergennes series) do not make good foundations because of their fine texture and the high water table. Over such soils, roads should be built on embankments, but this may not be practicable, especially if good material is not available. The gradeline should be kept several feet above the water table. If wet, fine-textured soil material is used in the subgrades or in embankments, the moisture content should be reduced so that it is not more than slightly above the optimum-

Association of State Highway Officials [1]

Silt-clay materials (More than 35 percent passing No. 200 sieve)				
A-4	A-5	A-6	A-7	
			A-7-5	A-7-6
36 minimum.	36 minimum.	36 minimum.	36 minimum.	36 minimum.
40 maximum. 10 maximum.	41 minimum. 10 maximum.	40 maximum. 11 minimum.	41 minimum. 11 minimum.[3]	41 minimum. 11 minimum.[3]
8 maximum.	12 maximum.	16 maximum.	20 maximum.	20 maximum.
Nonplastic to moderately plastic silty soils.	Highly elastic silts.	Medium plastic clays.	Highly plastic clays.	Highly plastic clays.
Fair to poor—Continued				

[2] NP=Nonplastic.
[3] Plasticity index of A-7-5 subgroup is equal to or less than LL minus 30. Plasticity index of A-7-6 subgroup is greater than LL minus 30.

TABLE 10.—*Characteristics of soil groups*

Major divisions		Group symbol	Soil description	Value as foundation material [2]	Value as base course directly under bituminous pavement
Coarse-grained soils (*50 percent or less passing No. 200 sieve*):	Gravels and gravelly soils (*more than half of coarse fraction retained on No. 4 sieve*).	GW	Well-graded gravels and gravel-sand mixtures; little or no fines.	Excellent	Good
		GP	Poorly graded gravels and gravel-sand mixtures; little or no fines.	Good to excellent	Poor to fair
		GM	Silty gravels and gravel-sand-silt mixtures.	Good	Poor to good
		GC	Clayey gravels and gravel-sand-clay mixtures.	Good	Poor
	Sands and sandy soils (*more than half of coarse fraction passing No. 4 sieve*).	SW	Well-graded sands and gravelly sands; little or no fines.	Good	Poor
		SP	Poorly graded sands and gravelly sands; little or no fines.	Fair to good	Poor to not suitable
		SM	Silty sands and sand-silt mixtures	Fair to good	Poor to not suitable
		SC	Clayey sands and sand-clay mixtures	Fair to good	Not suitable
Fine-grained soils (*more than 50 percent passing No. 200 sieve*):	Silts and clays (*liquid limit of 50 or less*).	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, and clayey silts of slight plasticity.	Fair to poor	Not suitable
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, and lean clays.	Fair to poor	Not suitable
		OL	Organic silts and organic clays having low plasticity.	Poor	Not suitable
	Silts and clays (*liquid limit greater than 50*).	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, and elastic silts.	Poor	Not suitable
		CH	Inorganic clays having high plasticity and fat clays.	Poor to very poor	Not suitable
		OH	Organic clays having medium to high plasticity and organic silts.	Poor to very poor	Not suitable
Highly organic soils		Pt	Peat and other highly organic soils	Not suitable	Not suitable

[1] Based on information in the Unified Soil Classification System, Tech. Memo. No. 3-357, V. 1, 2, and 3, Waterways Experiment Station, Corps of Engineers, 1953. Ratings and ranges in test values are for guidance only. Design should be based on field survey and test of samples from construction site.

[2] Ratings are for subgrade and subbases for flexible pavement.

in Unified soil classification system [1]

Value for embankments	Compaction: Characteristics and recommended equipment	Maximum dry density:[3] Approximate range in A.A.S.H.O.	Field (in-place) CBR	Subgrade modulus, k	Drainage characteristics	Comparable groups in A.A.S.H.O. classification
		Lb./cu. ft.		*Lb./sq. in./in.*		
Very stable; use in pervious shells of dikes and dams.	Good; use crawler-type tractor, pneumatic-tire roller, or steel-wheel roller.	125–135	60–80	300+	Excellent	A–1.
Reasonably stable; use in pervious shells of dikes and dams.	Same	115–125	25–60	300+	Excellent	A–1.
Reasonably stable; not particularly suited to shells, but may be used for impervious cores or blankets.	Good, but needs close control of moisture; use pneumatic-tire or sheepsfoot roller.	120–135	20–80	200–300+	Fair to practically impervious.	A–1 or A–2.
Fairly stable; may be used for impervious core.	Fair; use pneumatic-tire or sheepsfoot roller.	115–130	20–40	200–300	Poor to practically impervious.	A–2.
Very stable; may be used in pervious sections; slope protection required.	Good; use crawler-type tractor or pneumatic-tire roller.	110–130	20–40	200–300	Excellent	A–1.
Reasonably stable; may be used in dike sections having flat slopes.	Same	100–120	10–25	200–300	Excellent	A–1 or A–3.
Fairly stable; not particularly suited to shells, but may be used for impervious cores or dikes.	Good, but needs close control of moisture; use pneumatic-tire or sheepsfoot roller.	110–125	10–40	200–300	Fair to practically impervious.	A–1, A–2, or A–4.
Fairly stable; use as impervious cores for flood-control structures.	Fair; use pneumatic-tire roller or sheepsfoot roller.	105–125	10–20	200–300	Poor to practically impervious.	A–2, A–4, or A–6.
Poor stability; may be used for embankments if properly controlled.	Good to poor; close control of moisture is essential; use pneumatic-tire or sheepsfoot roller.	95–120	5–15	100–200	Fair to poor	A–4, A–5, or A–6.
Stable; use in impervious cores and blankets.	Fair to good; use pneumatic-tire or sheepsfoot roller.	95–120	5–15	100–200	Practically impervious.	A–4, A–6, or A–7.
Not suitable for embankments.	Fair to poor; use sheepsfoot roller.[4]	80–100	4–8	100–200	Poor	A–4, A–5, A–6, or A–7.
Poor stability; use in cores of hydraulic fill dams; not desirable in rolled fill construction.	Poor to very poor; use sheepsfoot roller.[4]	70–95	4–8	100–200	Fair to poor	A–5 or A–7.
Fair stability on flat slopes; use in thin cores, blankets, and dike sections of dams.	Fair to poor; use sheepsfoot roller.[4]	75–105	3–5	50–100	Practically impervious.	A–7.
Not suitable for embankments.	Poor to very poor; use sheepsfoot roller.[4]	65–100	3–5	50–100	Practically impervious.	A–5 or A–7.
Not used in embankments, dams, or subgrades for pavements					Fair to poor	None.

[3] Determined in accordance with A.A.S.H.O. Designation: T 99–49, Standard Method of Test for the Compaction and Density of Soils, published in Standard Method of Sampling and Testing Highway Materials, ed. 7, pt. II, illus. 1955.

[4] Pneumatic-tire rollers may be advisable, particularly when moisture content is higher than optimum.

TABLE 11.—*Summary of soil characteristics significant in engineering*

Map unit symbol	Soil	Natural drainage	Soil material and other significant characteristics
AaA AaB AaC	Amenia silt loam, 0 to 3 percent slopes Amenia silt loam, 3 to 8 percent slopes Amenia silt loam, 8 to 15 percent slopes	Moderately good	1½ to 3 feet of ML or CL (A-4 or A-6) developed on stony calcareous glacial till underlain by limestone in most places. Internal drainage impeded by dense layer at depth of about 2 feet; seepage occurs over this layer.
AbA AbB AbC	Amenia very stony silt loam, 0 to 3 percent slopes. Amenia very stony silt loam, 3 to 8 percent slopes. Amenia very stony silt loam, 8 to 15 percent slopes.	Moderately good	Similar to Amenia silt loam except that stones occur on the surface as well as throughout the profile. Small areas have slopes up to 35 percent.
BaA	Balch peat	Very poor	3 to 4 feet or more of fibrous organic material generally underlain by clay or glacial till; occurs in nearly level areas or depressions.
Bb	Beach and dune sand	Excessive [1]	2 feet or more of SP (A-3) generally overlying bedrock or clay or other soil material. Slopes dominantly 2 to 3 percent, but may range up to 25 percent.
BcA BcB BcC	Benson rocky loam, over massive limestone, 0 to 3 percent slopes. Benson rocky loam, over massive limestone, 3 to 8 percent slopes. Benson rocky loam, over massive limestone, 8 to 15 percent slopes.	Somewhat excessive to excessive.	½ to 2½ feet of GC, ML, or CL (A-2, A-4, or A-6) with limestone channers in glacial till underlain by massive limestone. In most areas bedrock is hard and massive locally. Bedrock outcrops occur at intervals of 50 feet or more.
BdA BdB BdC BdD BdE	Benson very rocky loam, over massive limestone, 0 to 3 percent slopes. Benson very rocky loam, over massive limestone, 3 to 8 percent slopes. Benson very rocky loam, over massive limestone, 8 to 15 percent slopes. Benson very rocky loam, over massive limestone, 15 to 25 percent slopes. Benson very rocky loam, over massive limestone, 25 to 35 percent slopes.	Somewhat excessive to excessive.	Similar to Benson rocky loam but bedrock outcrops are more numerous.
BeA BeB BeC BeD BeE BeF	Benson rocky silt loam, over shaly limestone, 0 to 3 percent slopes. Benson rocky silt loam, over shaly limestone, 3 to 8 percent slopes. Benson rocky silt loam, over shaly limestone, 8 to 15 percent slopes. Benson rocky silt loam, over shaly limestone, 15 to 25 percent slopes. Benson rocky silt loam, over shaly limestone, 25 to 35 percent slopes. Benson rocky silt loam, over shaly limestone, 35 to 50 percent slopes.	Somewhat excessive to excessive.	Similar to Benson rocky loam, but surface and subsoil layers contain somewhat more silt and, in most places, the bedrock is shaly and softer than that underlying Benson rocky loam.
BfB BfC BfD BfE	Benson very rocky silt loam, over shaly limestone, 3 to 8 percent slopes. Benson very rocky silt loam, over shaly limestone, 8 to 15 percent slopes. Benson very rocky silt loam, over shaly limestone, 15 to 25 percent slopes. Benson very rocky silt loam, over shaly limestone 25 to 50 percent slopes.	Somewhat excessive to excessive.	Similar to Benson rocky loam, but surface and subsoil layers contain somewhat more silt and, in most places, the bedrock is shaly and softer than that underlying Benson rocky loam. Outcrops are more numerous.
CaA	Carlisle muck	Very poor	2 to 4 feet of OL or OH (A-5) on nearly level areas or in depressions; underlain by fine-grained soil.
CbA CbB	Covington silty clay loam, 0 to 3 percent slopes. Covington silty clay loam, 3 to 8 percent slopes.	Somewhat poor to poor.	Marine sediments consisting of strata of ML, CL, MH, or CH (A-4, A-6, or A-7). Surface layer is high in organic matter. Sediments normally extend to depth of more than 3 feet but in places are underlain, at depths of 2 to 3 feet, by glacial till or limestone bedrock.
EaA EaB	Elmwood fine sandy loam, 0 to 3 percent slopes. Elmwood fine sandy loam, 3 to 8 percent slopes.	Moderately good	1 to 4 feet of moderately well drained SM or SC (A-2 or A-4) overlying marine clays (MH or CH; A-7). Perched water table. Seepage occurs over clay layer.
FaA	Fresh water marsh	Very poor	Under water most of the year.

See footnote at end of table.

TABLE 11.—*Summary of soil characteristics significant in engineering*—Continued

Map unit symbol	Soil	Natural drainage	Soil material and other significant characteristics
KaA	Kars fine sandy loam, 0 to 3 percent slopes	Somewhat excessive	2 to 5 feet of predominantly SM or GM over sand and gravel (SM, SP, GM, or GP) (A–1 or A–2) developed on delta and beach deposits; gravel content increases with depth; thin stratum of finer grained material in places. Dominant slopes 3 to 8 percent.
KaB	Kars fine sandy loam, 3 to 8 percent slopes		
KaC	Kars fine sandy loam, 8 to 15 percent slopes		
KaD	Kars fine sandy loam, 15 to 25 percent slopes		
KaE	Kars fine sandy loam, 25 to 50 percent slopes		
KbA	Kendaia silt loam, 0 to 3 percent slopes	Somewhat poor to poor.	About 2 feet of ML or CL (A–4 or A–6) derived from calcareous glacial till; in places, limestone bedrock at depths of 1½ to 3 feet.
KbB	Kendaia silt loam, 3 to 8 percent slopes		
KcA	Kendaia very stony silt loam, 0 to 3 percent slopes.	Somewhat poor to poor.	Similar to Kendaia silt loam except that numerous stones occur on surface as well as throughout profile.
KcB	Kendaia very stony silt loam, 3 to 8 percent slopes.		
LaA	Livingston silty clay loam, 0 to 3 percent slopes.	Very poor	About 1 foot of muck or silty clay high in organic matter (Pt or OH; A–5) over CH (A–7) derived from marine sediments; occurs in nearly level areas or in depressions.
LbA	Lyons silt loam, 0 to 3 percent slopes	Very poor	About 2 feet of ML or CL (A–4 or A–6) over SM or SC (A–2 or A–4); occurs in depressions in glacial till. In places, the surface layer, to a depth ranging up to 1½ feet, is highly organic (Pt or OL; A–5).
LcA	Lyons very stony silt loam, 0 to 3 percent slopes.	Very poor	Similar to Lyons silt loam, except that stones occur on surface as well as throughout soil profile.
MaA	Melrose fine sandy loam, 0 to 3 percent slopes	Good	1 to 4 feet of SM or SC (A–2 or A–4) over marine silts and clays (CL or CH; A–6 or A–7). Seepage occurs over clay layer. Dominant slope 1 to 8 percent.
MaB	Melrose fine sandy loam, 3 to 8 percent slopes		
MaC	Melrose fine sandy loam, 8 to 15 percent slopes		
MaD	Melrose fine sandy loam, 15 to 25 percent slopes		
NaA	Nellis silt loam, 0 to 3 percent slopes	Good	ML or CL (A–4 or A–6); contains shale and limestone fragments; developed from glacial till; quantity of shale and limestone fragments varies considerably from place to place. In places, limestone bedrock or sandy and gravelly materials occur at depth of 2 feet or more. Dominant slopes 3 to 8 percent.
NaB	Nellis silt loam, 3 to 8 percent slopes		
NaC	Nellis silt loam, 8 to 15 percent slopes		
NaD	Nellis silt loam, 15 to 25 percent slopes		
NbA	Nellis very stony silt loam, 0 to 3 percent slopes.	Good	Similar to Nellis silt loam except that many stones occur on the surface and throughout the soil profile.
NbB	Nellis very stony silt loam, 3 to 8 percent slopes.		
NbC	Nellis very stony silt loam, 8 to 15 percent slopes.		
NbD	Nellis very stony silt loam, 15 to 25 percent slopes.		
SaB	St. Albans-Dutchess loams, 3 to 8 percent slopes.	Good to excessive	½ to 3 feet of ML or CL (A–4 or A–6), containing shale and slate fragments; developed from glacial till on shales and slates. Seepage occurs over bedrock.
SbB	St. Albans-Dutchess rocky loams, 3 to 8 percent slopes.	Good to excessive	Similar to St. Albans-Dutchess loams except that rock outcrops occur at intervals of 50 to 200 feet.
SbC	St. Albans-Dutchess rocky loams, 8 to 15 percent slopes.		
ScB	St. Albans-Dutchess very rocky loams, 3 to 8 percent slopes.	Good to excessive	Similar to St. Albans-Dutchess rocky loams except that rock outcrops are more numerous.
ScD	St. Albans-Dutchess very rocky loams, 15 to 25 percent slopes.		
SdA	Swanton fine sandy loam, 0 to 3 percent slopes	Somewhat poor to poor.	1 to 4 feet of SM, SC, ML, or CL (A–2, A–4, or A–6) underlain by marine clay (CL or CH; A–6 or A–7). Seasonal water table at depths of 1 to 4 feet.
SdB	Swanton fine sandy loam, 3 to 8 percent slopes		
VaA	Vergennes silty clay loam, 0 to 3 percent slopes.	Moderately good	CL or CH (A–6 or A–7); derived from marine silts and clays. In some areas, limestone bedrock or glacial till occur at depths of 2 to 3 feet. Dominant slopes of 3 to 8 percent.
VaB	Vergennes silty clay loam, 3 to 8 percent slopes.		
WaA	Whately loam, 0 to 3 percent slopes	Very poor	1 to 4 feet of ML or OL (A–4) and SP (A–3) over marine silts and clays (CH; A–7). In places, muck surface layer is as much as 1½ feet thick. Occurs primarily in flat areas or depressions.

[1] Many areas flooded when lake level is high.

TABLE 12.—*Engineering properties of soil series*

[Based on interpretation of soil survey data]

Soil series	Suitability for winter grading	Suitability for topsoil [1]	Susceptibility to frost action	Depth (typical profile)	Structure	pH	Un
				Inches			
Amenia	Fair to poor	Good	Moderate to high	0–14	Granular	6.5	ML o
				14–25	Blocky	6.5–7.5	ML o
				25+	Blocky or platy	7.5+	ML o
Balch peat	Not suitable	Not suitable		0–36+		−5.0	Pt
Beach and dune sand	Good	Not suitable	Slight to moderate [2]	0–24+	Single grained	6.4	SP
Benson	Fair to good	Fair to good	Slight to moderate [2]	0–9	Granular	6.8	ML o
				9–16	Blocky	7.0	ML o
				16–21	Blocky	7.5	GC
Carlisle muck	Not suitable	Poor		0–9	Granular	7.0	OL
				9–40		7.0	OL o
				40+		7.0	ML o
Covington	Poor or not suitable.	Fair to good	High	0–7	Granular	5.6	ML o
				7–35	Blocky	7.0	CH
				35+	Platy	7.0–7.5	CH
Elmwood	Fair to poor	Good	Moderate to high [2]	0–10	Granular	5.5	SM o
				10–31	Blocky	5.2–5.6	SM o
				31+	Platy	6.2	MH o
Kars	Good	Fair	None to slight	0–9	Granular	6.2	SM o
				9–35	Granular	6.6	SM
				35–40	Blocky	7.5+	CL
				40+	Single grained	7.5+	SM, S or
Kendaia	Poor	Fair to poor	High	0–6	Granular	7.0	ML o
				6–16	Blocky	7.0–7.5	ML o
				16–23+	Platy	7.5+	ML o
Livingston	Not suitable	Poor	High	0–11	Weak granular	6.6	Pt or
				11–15	Massive	7.2	CH
				15–32	Blocky	7.2	CH
				32+	Massive	7.2+	MH o
Lyons	Not suitable	Poor	High	0–4	Granular	6.4	ML o
				4–17	Blocky	7.0	ML o
				17–25	Massive	7.2	ML o
				25+	Platy	7.5+	ML
Melrose	Fair to poor	Fair	High	0–9	Granular	5.6	SM o
				9–17	Blocky	5.8–6.2	SM o
				17+	Blocky	6.2	CL o
Nellis	Fair	Good	Slight to moderate	0–8	Granular	6.2	ML o
				8–18	Blocky	6.6	CL
				18+	Platy	7.5	CL
St. Albans-Dutchess [3]	Fair to good	Poor	Moderate [2]	0–8	Granular	5.6	ML o
				8–12	Blocky	5.2	ML o
				12–24	Platy	6.3	ML o
				24+	Blocky	7.4	ML o
Swanton	Poor	Poor	High	0–9	Granular	6.5	SM o
				9–11	Single grained	6.6	SM
				11–35	Blocky	7.0	SM o
				42+	Blocky	7.0	CH
Vergennes	Poor	Poor to fair	Moderate to high	0–7	Granular	6.4	CL o
				7–25	Blocky	6.5	CL o
				25+		7.0	CL o
Whately	Not suitable	Poor	High	0–7	Granular	5.8	ML o
				7–15	Single grained	6.6	SP
				15+	Massive	6.6	CH

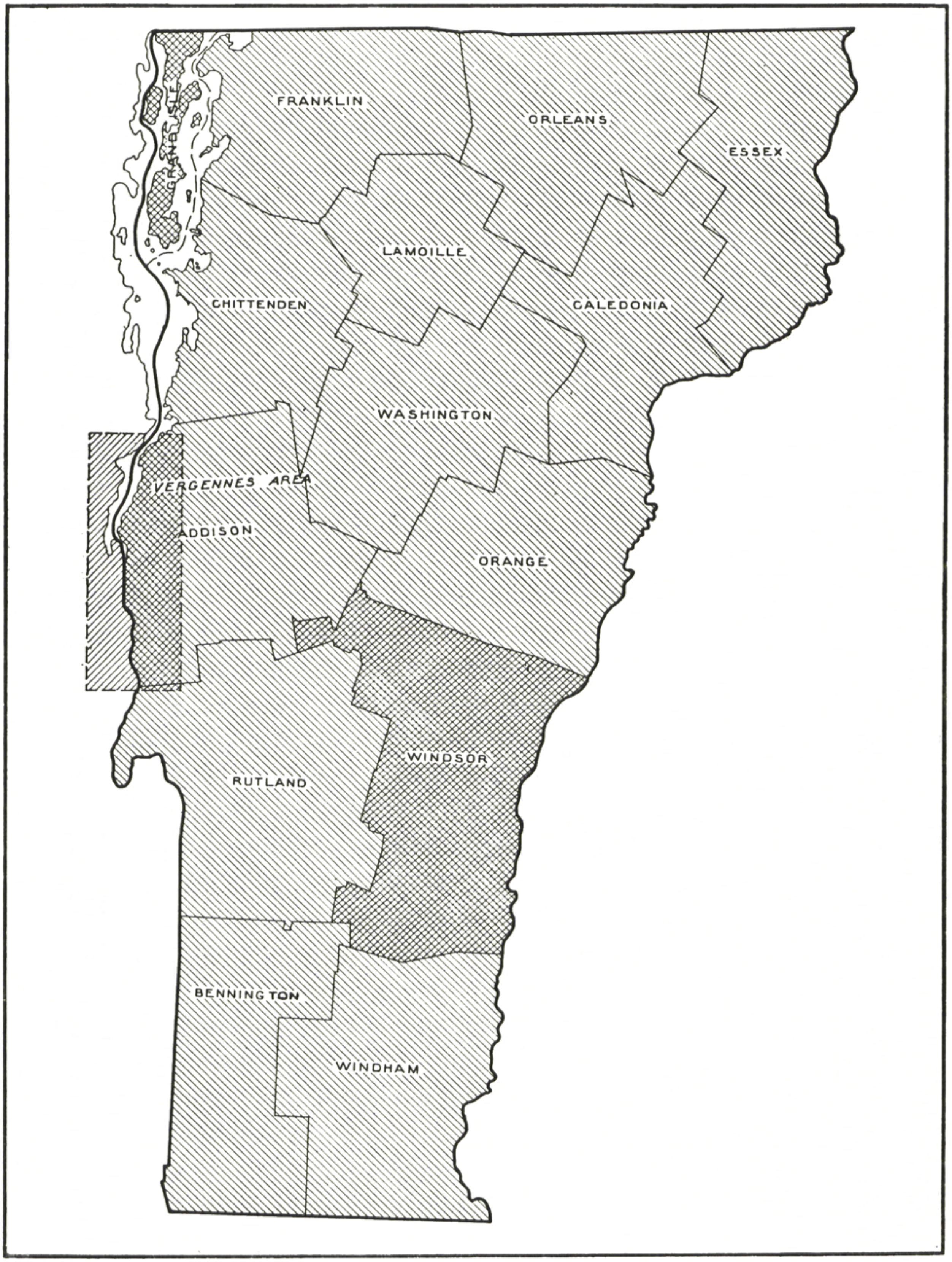
[1] Ratings are for the nonstony phases and refer to the surface layer.
[2] Susceptibility to frost action depends upon the underlying soil material or bedrock and depth to water table.
[3] Properties are for typical St. Albans soil. The more strongly acid throughout.

moisture content; otherwise, the material cannot be adequately compacted.

Peat and muck are not suitable foundations for roads or other engineering structures because of their low strength and their normally high water table. If possible, roads should be aligned to avoid peat and muck. When these organic materials occur within a roadway cut section or at an embankment site, they should be removed and replaced with coarse-grained soil material. Not all the very small areas of peat or muck are shown on the map.

Field exploration should be made to find material that is suitable for specific construction projects. The Kars soil is the best source of sand and gravel in the county. A limited amount of sand occurs in some areas of the Melrose, Elmwood, Swanton, and Whately soils, but it may be difficult to obtain from the Swanton and Whately soils because of the high water table. Dunes are a good source of sand. Beach deposits may be under water if the level of the lake is high.

The soil map and soil profile descriptions should be used in planning detailed surveys at construction sites. These maps and descriptions indicate sources of sand and gravel. They enable the engineers to concentrate on the most suitable soils, and minimize the number of samples that will be required for laboratory testing.



Areas surveyed in Vermont shown by shading. Detailed surveys shown by northeast-southwest hatching (in New York State); reconnaissance surveys shown by northwest-southeast hatching; crosshatching indicates areas covered by both detailed and reconnaissance surveys.

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program information (e.g., Braille, large print, audiotape, etc.), please contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).

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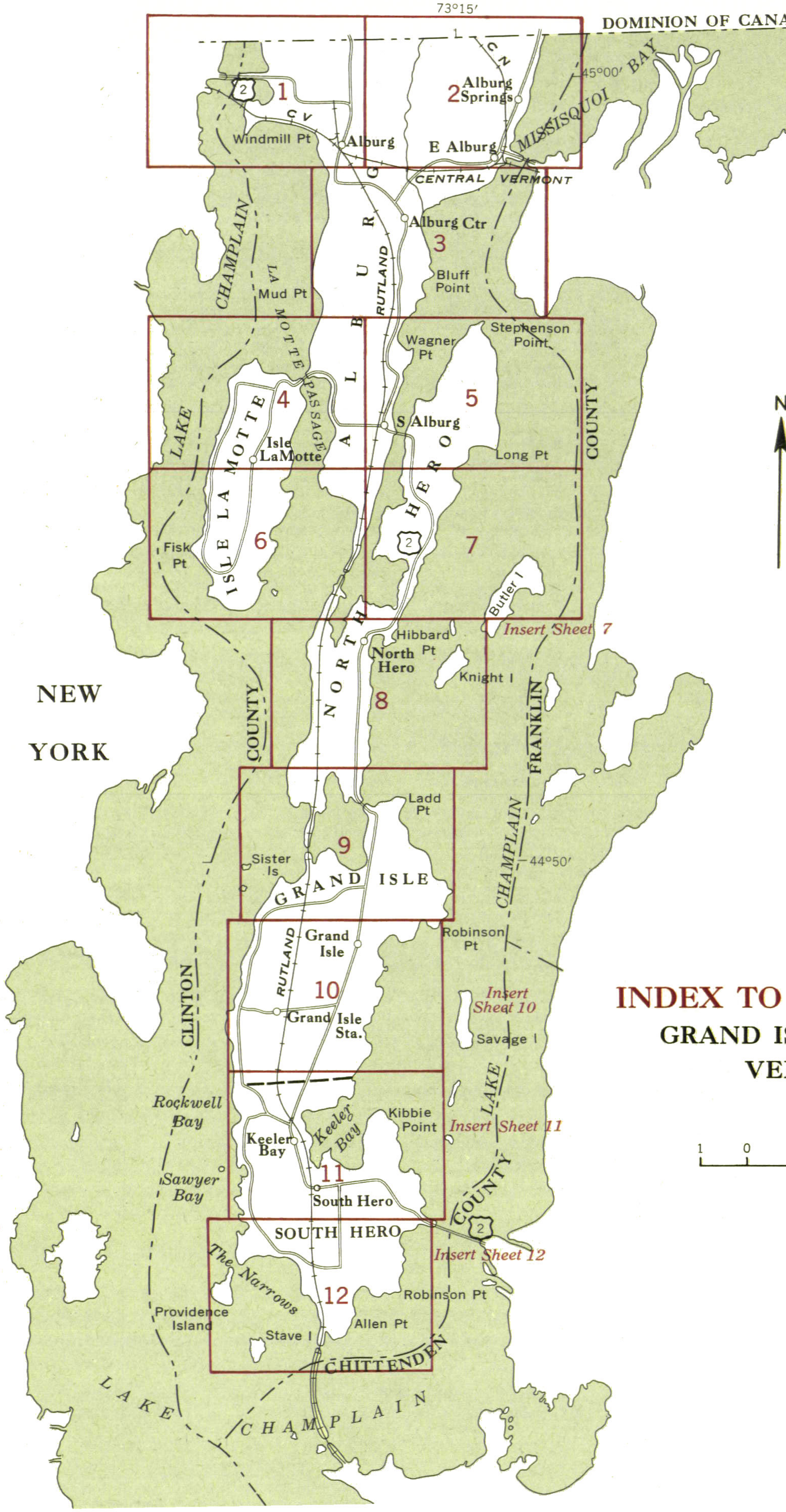
For additional information dealing with Supplemental Nutrition Assistance Program (SNAP) issues, call either the USDA SNAP Hotline Number at (800) 221-5689, which is also in Spanish, or the State Information/Hotline Numbers (http://directives.sc.egov.usda.gov/33085.wba).

All Other Inquiries

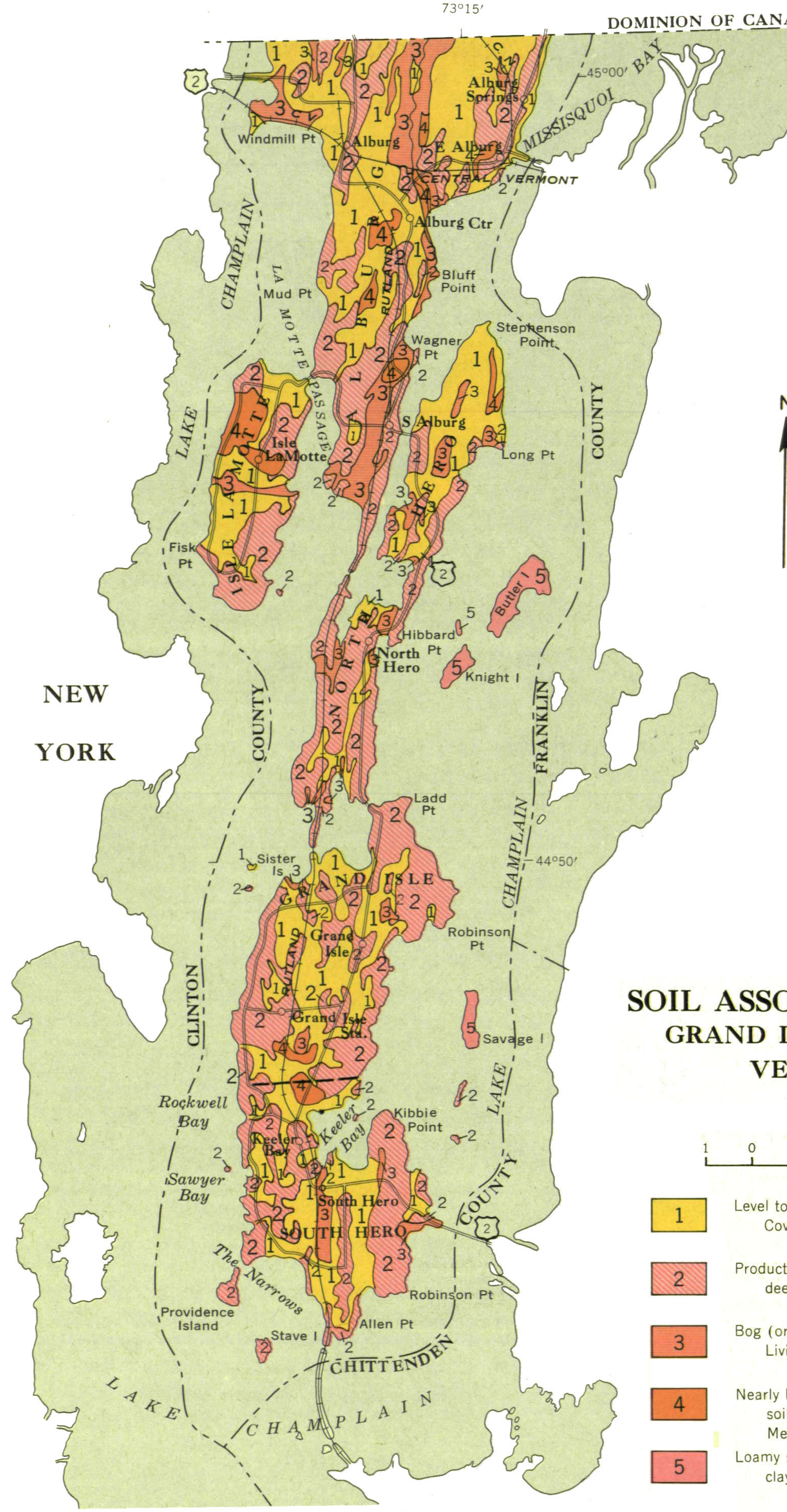
For information not pertaining to civil rights, please refer to the listing of the USDA Agencies and Offices (http://directives.sc.egov.usda.gov/33086.wba).



INDEX TO MAP SHEETS

GRAND ISLE COUNTY, VERMONT

1 0 1 2 3 4 MILES



SOIL ASSOCIATION MAP

GRAND ISLE COUNTY, VERMONT

1 0 1 2 3 4 MILES

1. Level to gently sloping, wet and slightly wet soils: Covington, Kendaia, Swanton, Amenia.
2. Productive loamy soils - most are shallow, but some are deep to limestone bedrock: Benson, Amenia, Nellis.
3. Bog (organic) soils and very wet clay soils: Carlisle, Livingston, Balch.
4. Nearly level or gently sloping deep sandy and gravelly soils, and sandy soils underlain by clay: Kars, Elmwood, Melrose.
5. Loamy soils shallow to slate or shale bedrock and deep wet clayey soils: St. Albans, Dutchess, Covington.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

GRAND ISLE COUNTY, VERMONT

VERMONT AGRICULTURAL EXPERIMENT STATION

SOILS LEGEND

SYMBOL	NAME
AaA	Amenia silt loam, 0-3 percent slopes
AaB	Amenia silt loam, 3-8 percent slopes
AaC	Amenia silt loam, 8-15 percent slopes
AbA	Amenia very stony silt loam, 0-3 percent slopes
AbB	Amenia very stony silt loam, 3-8 percent slopes
AbC	Amenia very stony silt loam, 8-15 percent slopes
BaA	Balch peat
Bb	Beach and dune sand
BcA	Benson rocky loam, over massive limestone, 0-3 percent slopes
BcB	Benson rocky loam, over massive limestone, 3-8 percent slopes
BcC	Benson rocky loam, over massive limestone, 8-15 percent slopes
BdA	Benson very rocky loam, over massive limestone, 0-3 percent slopes
BdB	Benson very rocky loam, over massive limestone, 3-8 percent slopes
BdC	Benson very rocky loam, over massive limestone, 8-15 percent slopes
BdD	Benson very rocky loam, over massive limestone, 15-25 percent slopes
BdE	Benson very rocky loam, over massive limestone, 25-35 percent slopes
BeA	Benson rocky silt loam, over shaly limestone, 0-3 percent slopes
BeB	Benson rocky silt loam, over shaly limestone, 3-8 percent slopes
BeC	Benson rocky silt loam, over shaly limestone, 8-15 percent slopes
BeD	Benson rocky silt loam, over shaly limestone, 15-25 percent slopes
BeE	Benson rocky silt loam, over shaly limestone, 25-35 percent slopes
BeF	Benson rocky silt loam, over shaly limestone, 35-50 percent slopes
BfB	Benson very rocky silt loam, over shaly limestone, 3-8 percent slopes
BfC	Benson very rocky silt loam, over shaly limestone, 8-15 percent slopes
BfD	Benson very rocky silt loam, over shaly limestone, 15-25 percent slopes
BfE	Benson very rocky silt loam, over shaly limestone, 25-50 percent slopes
CaA	Carlisle muck
CbA	Covington silty clay loam, 0-3 percent slopes
CbB	Covington silty clay loam, 3-8 percent slopes
EaA	Elmwood fine sandy loam, 0-3 percent slopes
EaB	Elmwood fine sandy loam, 3-8 percent slopes
FaA	Fresh water marsh
KaA	Kars fine sandy loam, 0-3 percent slopes
KaB	Kars fine sandy loam, 3-8 percent slopes
KaC	Kars fine sandy loam, 8-15 percent slopes
KaD	Kars fine sandy loam, 15-25 percent slopes
KaE	Kars fine sandy loam, 25-50 percent slopes
KbA	Kendaia silt loam, 0-3 percent slopes
KbB	Kendaia silt loam, 3-8 percent slopes
KcA	Kendaia very stony silt loam, 0-3 percent slopes
KcB	Kendaia very stony silt loam, 3-8 percent slopes
LaA	Livingston silty clay loam, 0-3 percent slopes
LbA	Lyons silt loam, 0-3 percent slopes
LcA	Lyons very stony silt loam, 0-3 percent slopes
MaA	Melrose fine sandy loam, 0-3 percent slopes
MaB	Melrose fine sandy loam, 3-8 percent slopes
MaC	Melrose fine sandy loam, 8-15 percent slopes
MaD	Melrose fine sandy loam, 15-25 percent slopes
NaA	Nellis silt loam, 0-3 percent slopes
NaB	Nellis silt loam, 3-8 percent slopes
NaC	Nellis silt loam, 8-15 percent slopes
NaD	Nellis silt loam, 15-25 percent slopes
NbA	Nellis very stony silt loam, 0-3 percent slopes
NbB	Nellis very stony silt loam, 3-8 percent slopes
NbC	Nellis very stony silt loam, 8-15 percent slopes
NbD	Nellis very stony silt loam, 15-25 percent slopes
SaB	St. Albans-Dutchess loams, 3-8 percent slopes
SbB	St. Albans-Dutchess rocky loams, 3-8 percent slopes
SbC	St. Albans-Dutchess rocky loams, 8-15 percent slopes
ScB	St. Albans-Dutchess very rocky loams, 3-8 percent slopes
ScD	St. Albans-Dutchess very rocky loams, 15-25 percent slopes
SdA	Swanton fine sandy loam, 0-3 percent slopes
SdB	Swanton fine sandy loam, 3-8 percent slopes
VaA	Vergennes silty clay loam, 0-3 percent slopes
VaB	Vergennes silty clay loam, 3-8 percent slopes
WaA	Whately loam, 0-3 percent slopes

Soils surveyed 1946-55 by S. L. Zayach and W. J. Ellyson, Soil Conservation Service.
Correlation by Walter H. Lyford, U. S. Department of Agriculture.

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Roads
- Good motor
- Poor motor
- Trail
- Marker, U. S.

33

Railroads
- Single track
- Multiple track
- Abandoned

Bridges and crossings
- Road
- Trail, foot
- Railroad
- Ferry
- Ford
- Grade
- R. R. over
- R. R. under
- Tunnel

Buildings
- School
- Church
- Station

Mine and Quarry
- Shaft
- Dump
- Prospect

Pits, gravel or other

Power line

Pipeline

Cemetery

Dam

Levee

Tank

Oil well

Windmill

Canal lock (point upstream)

BOUNDARIES

- National or state
- County
- Township, civil
- U. S.
- Section
- City (corporate)
- Reservation
- Land grant

DRAINAGE

Streams
- Perennial
- Intermittent, unclass.
- Crossable with tillage implements
- Not crossable with tillage implements

Canals and ditches

CANAL

DITCH

Lakes and ponds
- Perennial
- Intermittent

Wells

flowing

Springs

Marsh

Wet spot

RELIEF

Escarpments
- Bedrock
- Other

Prominent peaks

Depressions

	Large	Small
Crossable with tillage implements		
Not crossable with tillage implements		
Contains water most of the time		

SOIL SURVEY DATA

Soil type outline and symbol — Dx

Gravel

Stones

Rock outcrops

Chert fragments

Clay spot

Sand spot

Gumbo or scabby spot

Made land

Erosion
- Uneroded spot — U
- Sheet, moderate — S
- Sheet, severe — SS
- Gully, moderate — G
- Gully, severe — GG
- Sheet and gully, moderate — SG
- Wind, moderate
- Wind, severe
- Blowout
- Wind hummock
- Overblown soil

Gullies
- Crossable with tillage implements
- Not crossable with tillage implements

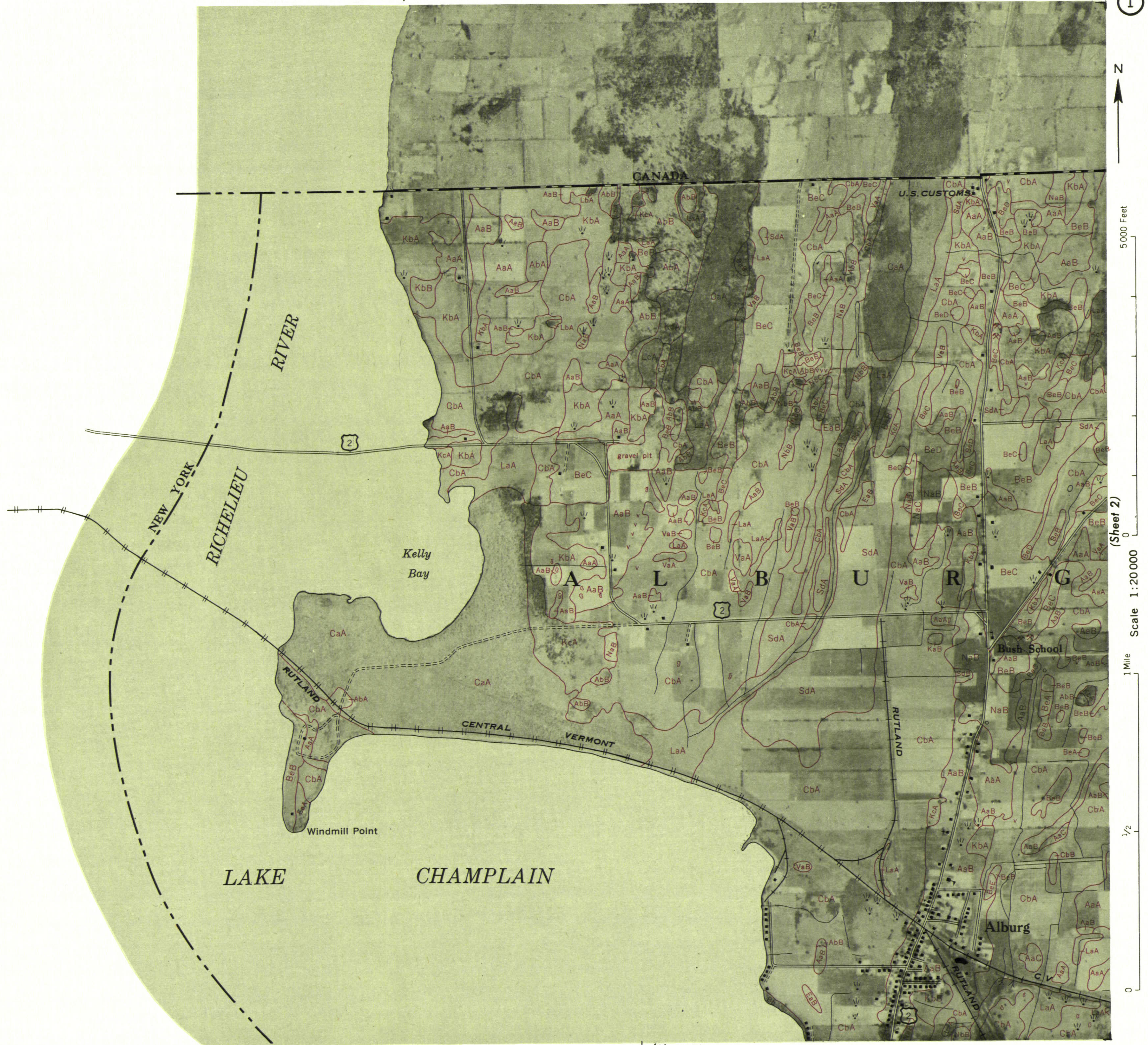
Areas of alkali and salts
- Strong — A
- Moderate — M
- Slight — S
- Free of toxic effect — F

Sample location — 26

Saline spot

Soil map constructed 1956 by Cartographic Division, Soil Conservation Service, USDA, from 1942 aerial photographs. Controlled mosaic based on polyconic projection, 1927 North American datum.

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1942.



(Sheet 2)

(Sheet 3)

(Sheet 9)

N

Scale 1:20000

5000 Feet

0

1 Mile

1/2

0

(Sheet 11)

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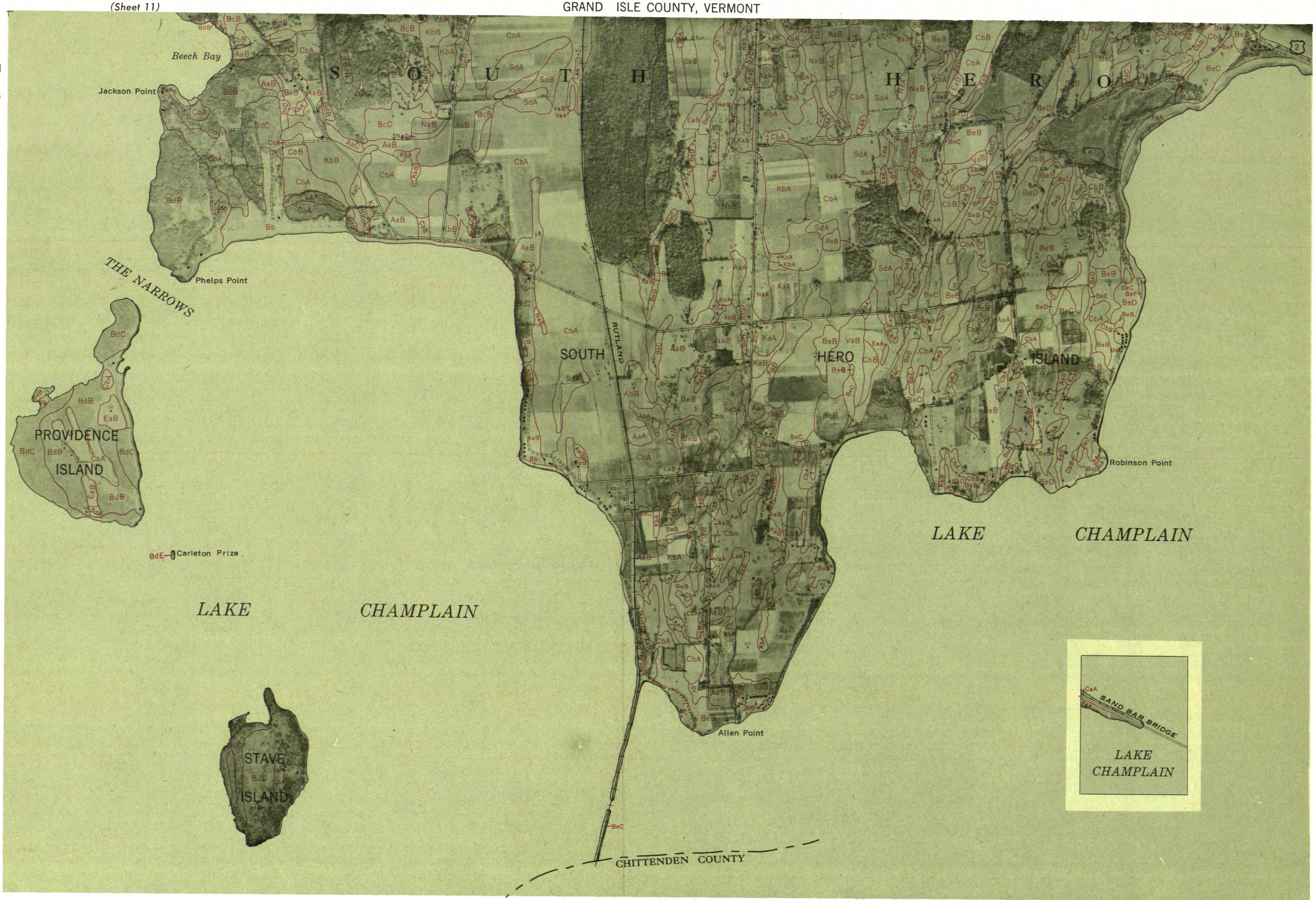

N

Scale 1:20000

5000 Feet

1 Mile

(Inset)


N
5000 Feet
0
Scale 1:20000
1 Mile
1/2
0
(Sheet 1)
CANADA
U. S. CUSTOMS
Chapman Bay
A L B U R G
Alburg Springs
Mud Creek
FRANKLIN COUNTY
MISSISQUOI BAY
CANADIAN NATIONAL
CENTRAL VERMONT
gravel pit
East Alburg
(Sheet 3)

(Sheet 1) | (Sheet 2) GRAND ISLE COUNTY, VERMONT

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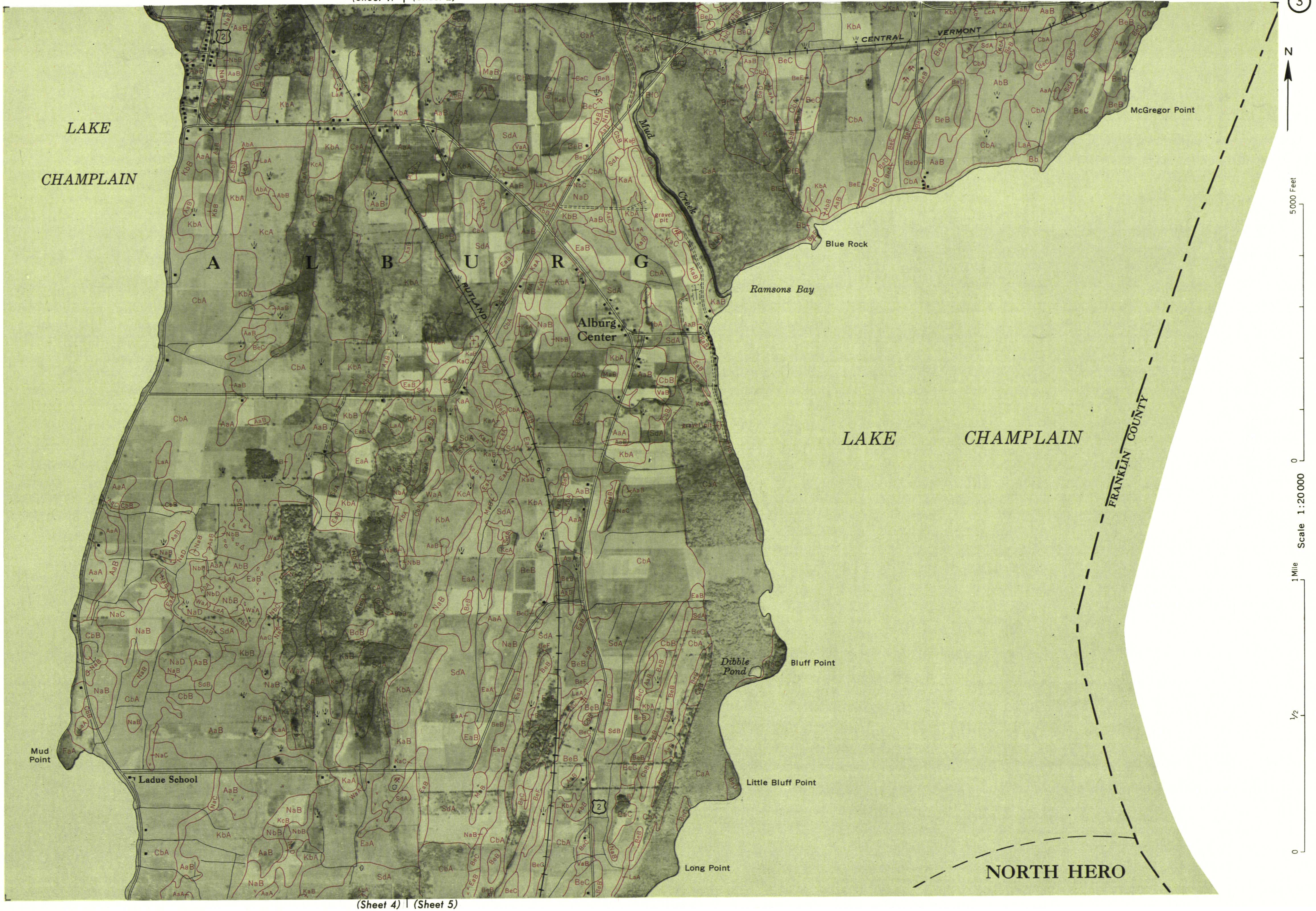
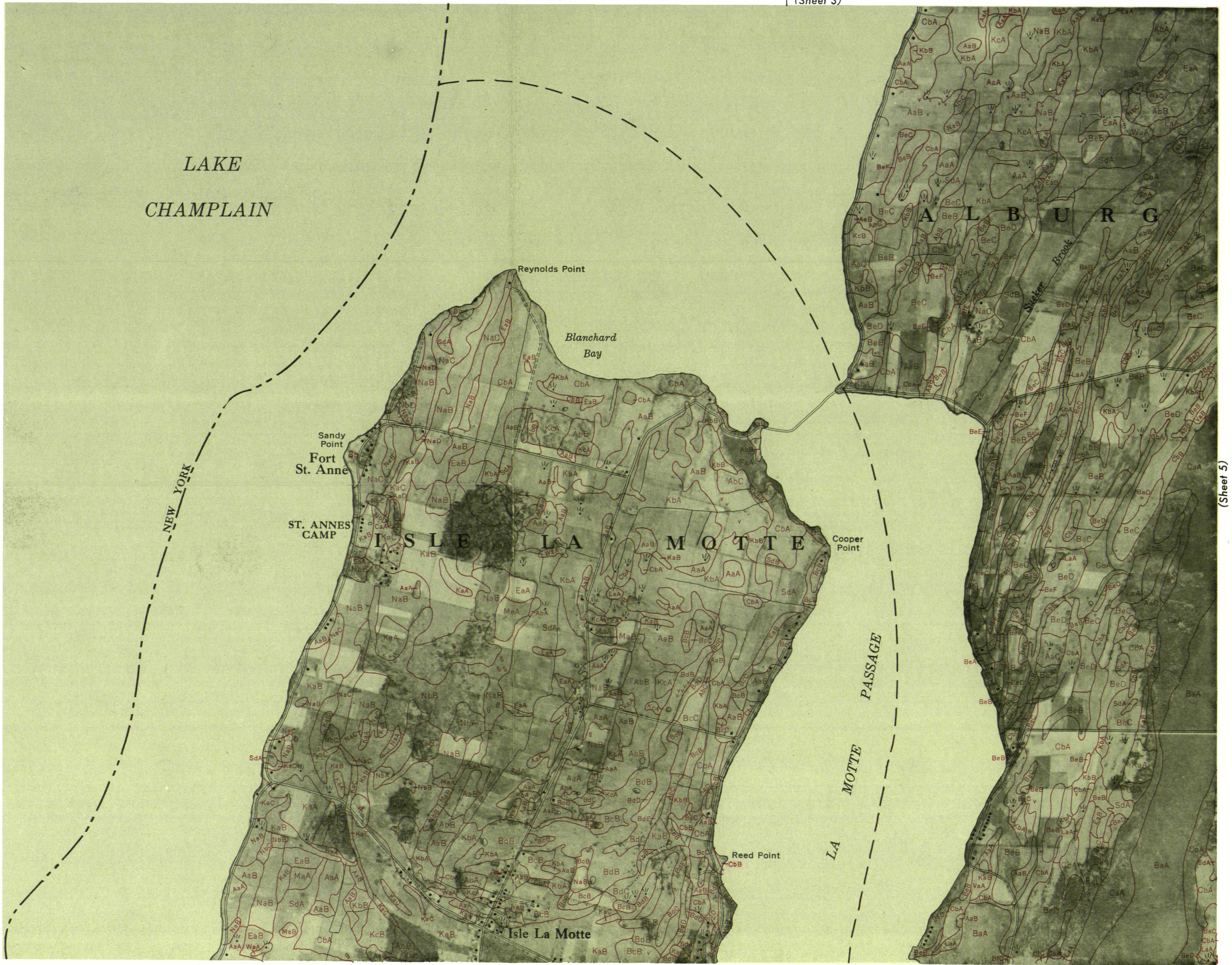


(Sheet 4) | (Sheet 5)

(Sheet 3)



N

Scale 1:20000

1 Mile

½

0

5000 Feet

0

(Sheet 5)

(Sheet 6)

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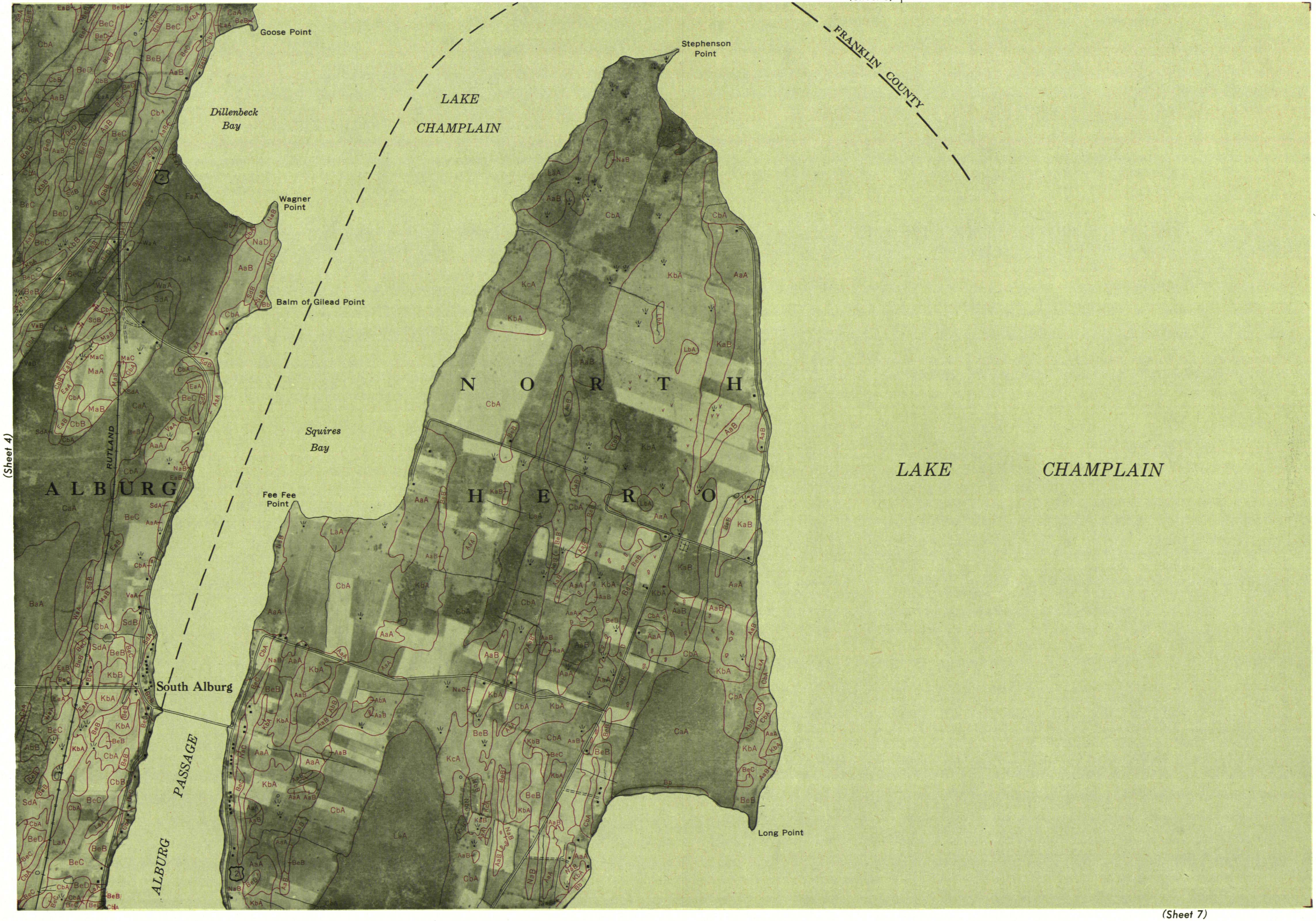


N

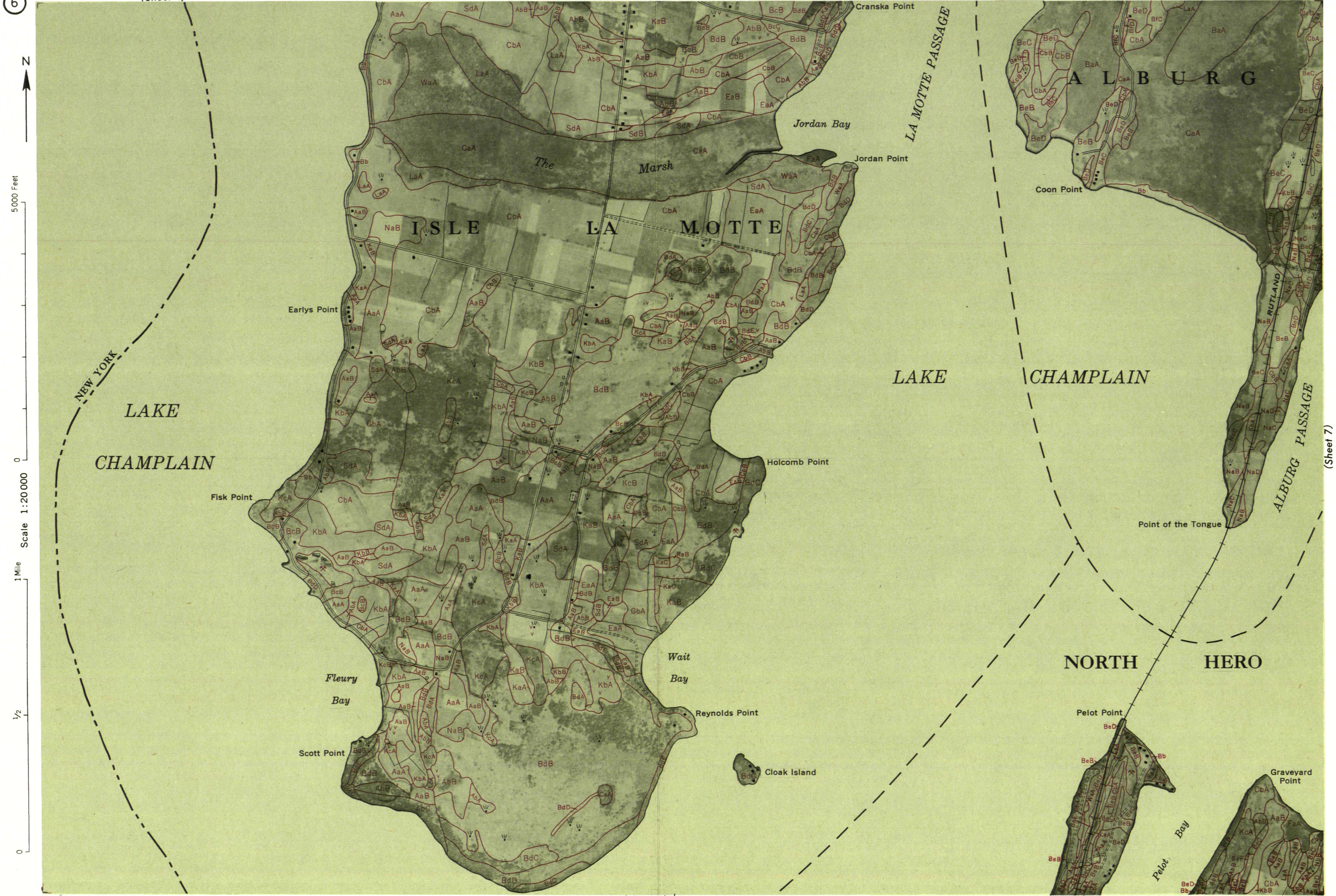
Scale 1:20000

5000 Feet
0

1 Mile
½
0

(Sheet 7)

(Sheet 4)



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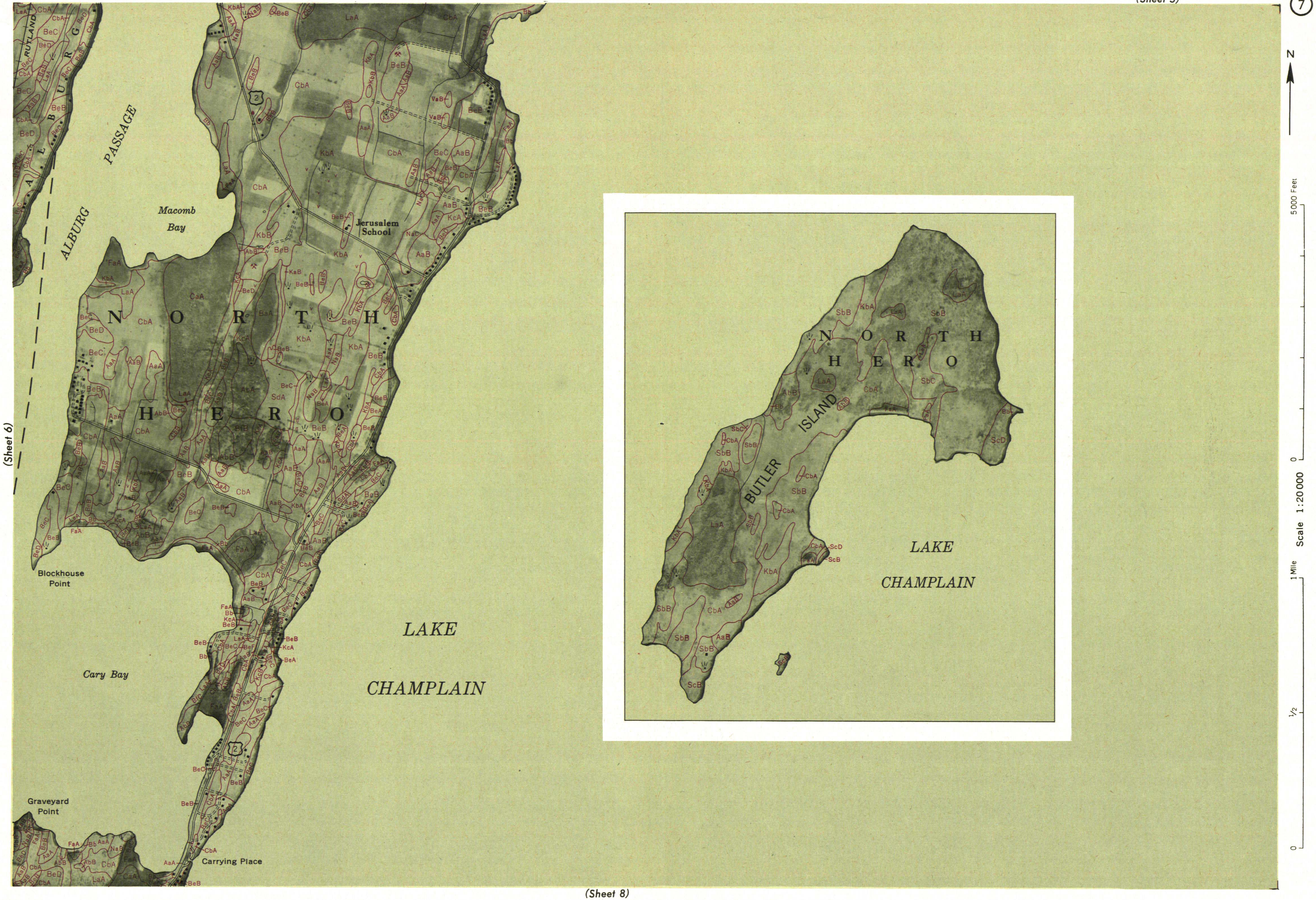

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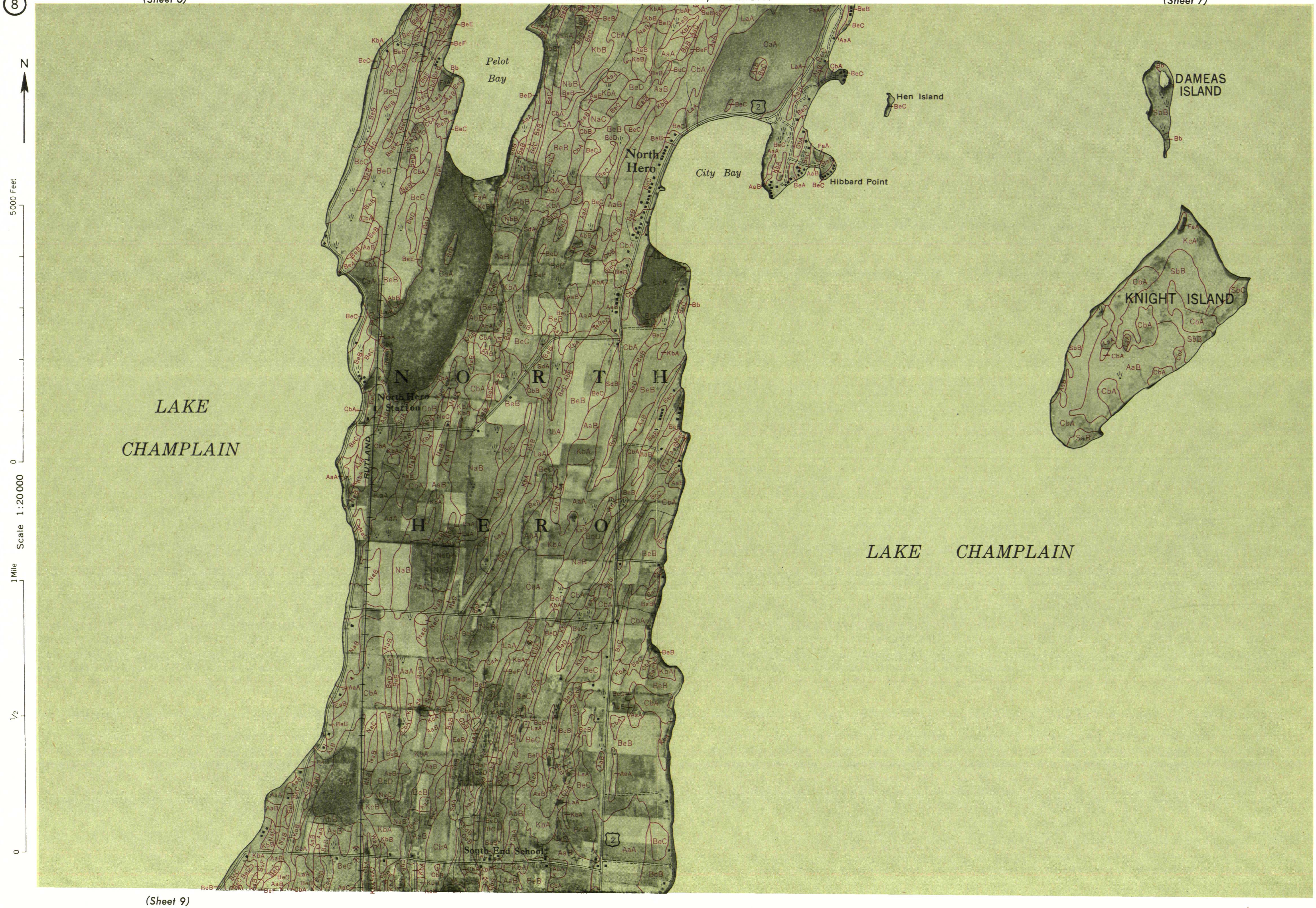
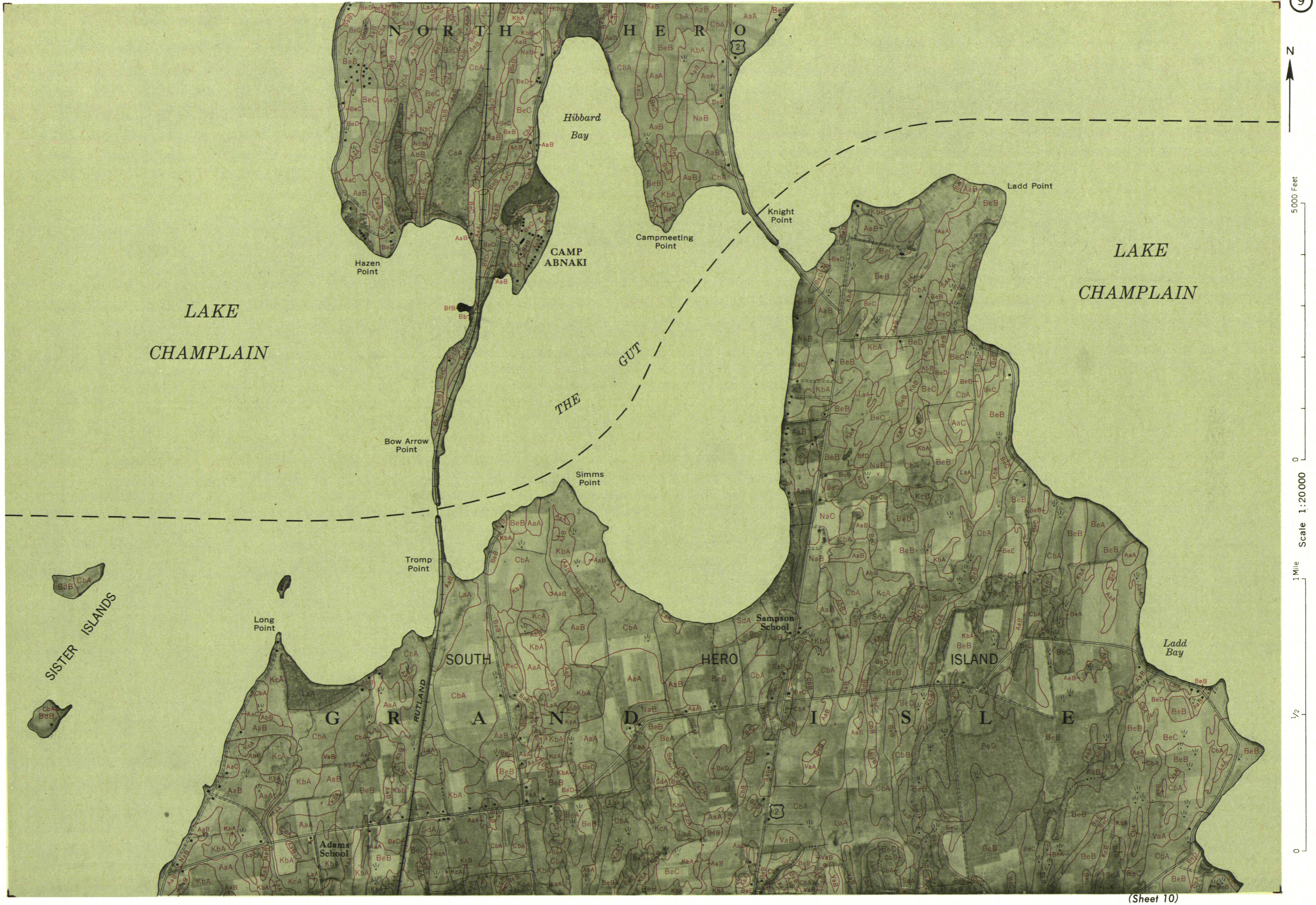

N
5000 Feet
0
Scale 1:20000
1 Mile
1/2
0
Pelot Bay
North Hero
City Bay
Hen Island
Hibbard Point
DAMEAS ISLAND
KNIGHT ISLAND
LAKE CHAMPLAIN
NORTH HERO
North Hero Station
RUTLAND
LAKE CHAMPLAIN
South End School



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